Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

AUGUST 1954

VOLUME 37 • NUMBER 8

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		13. Suspension

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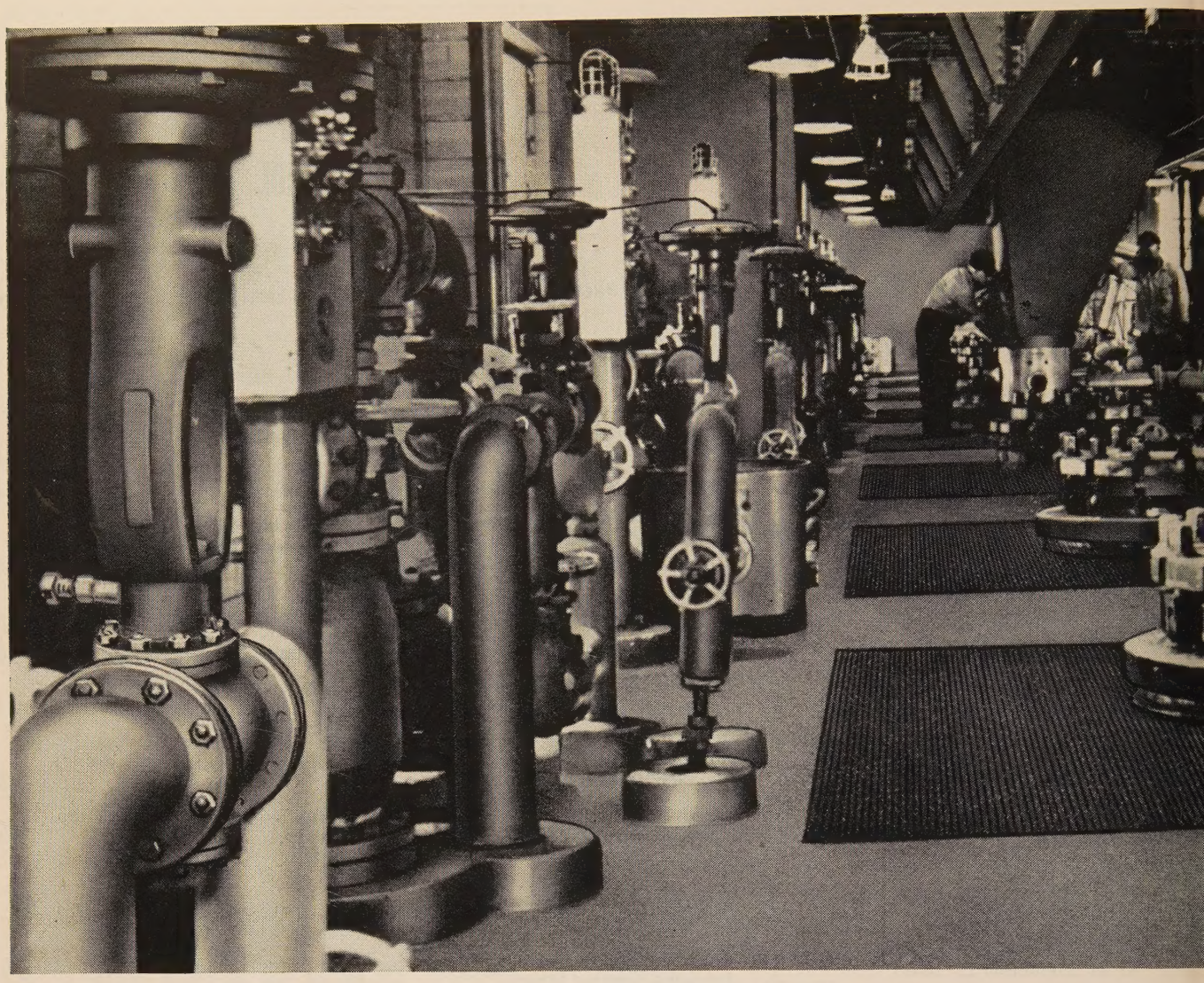

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Lower Steam Consumption

You'll use from 4 to 15% less steam per ton of pulp.

Better Boiler House Loading

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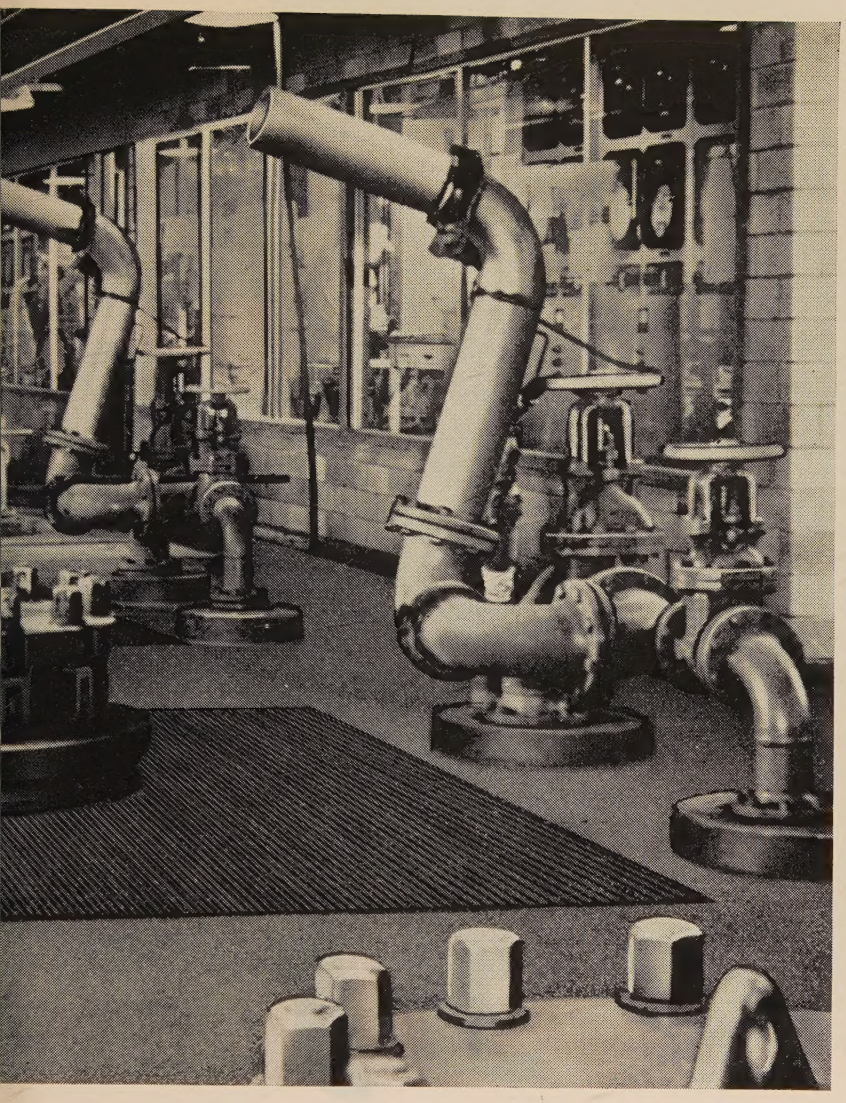
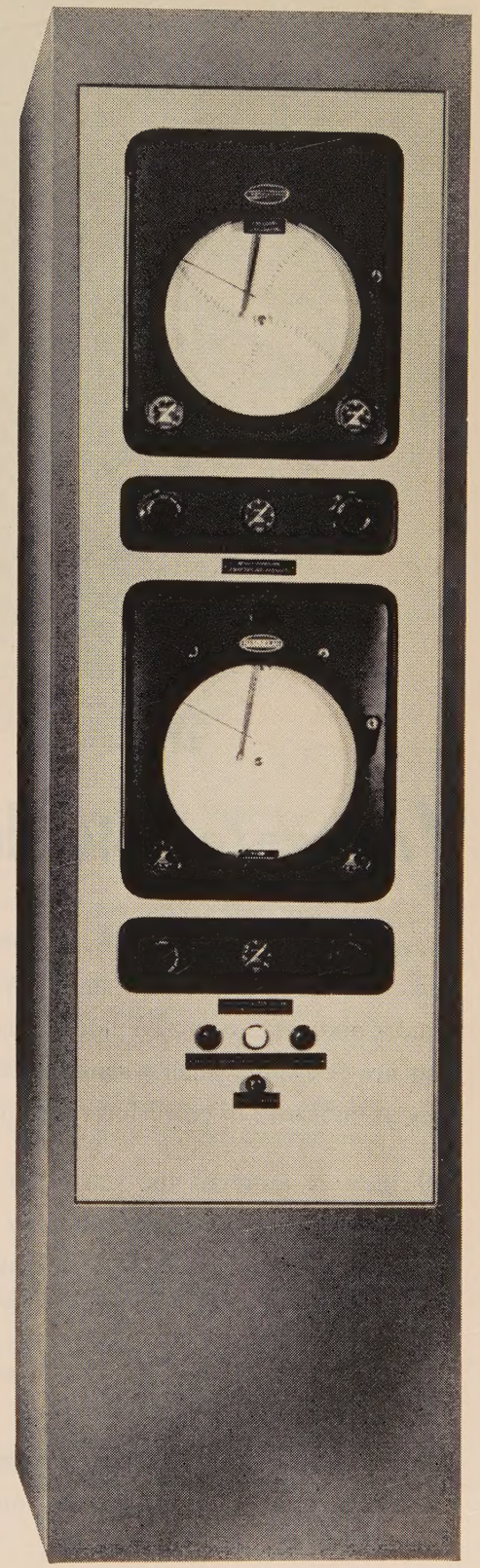
*Name on reques



A battery of digesters in a Southern mill, building profits with Masoneilan Controls.



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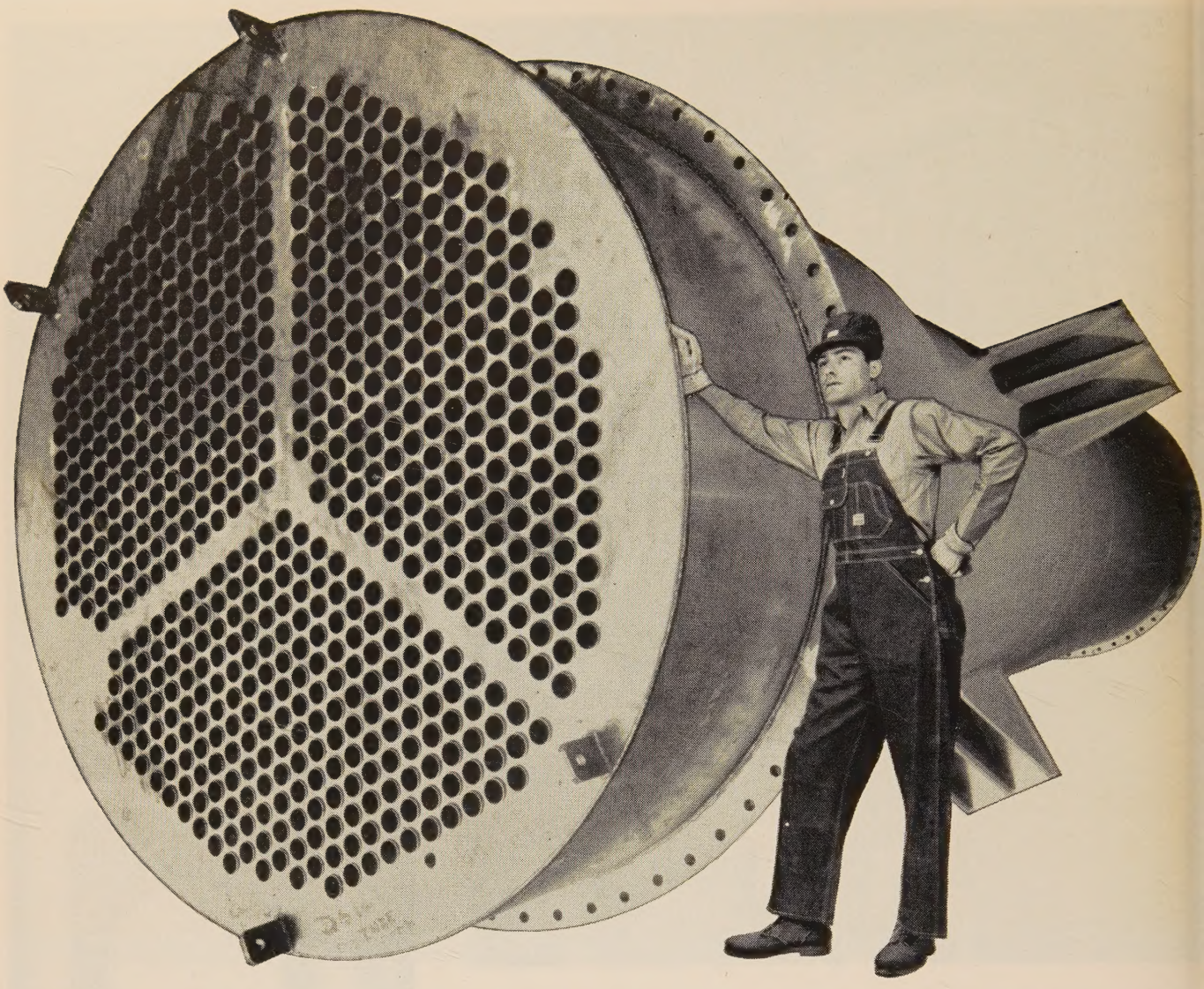

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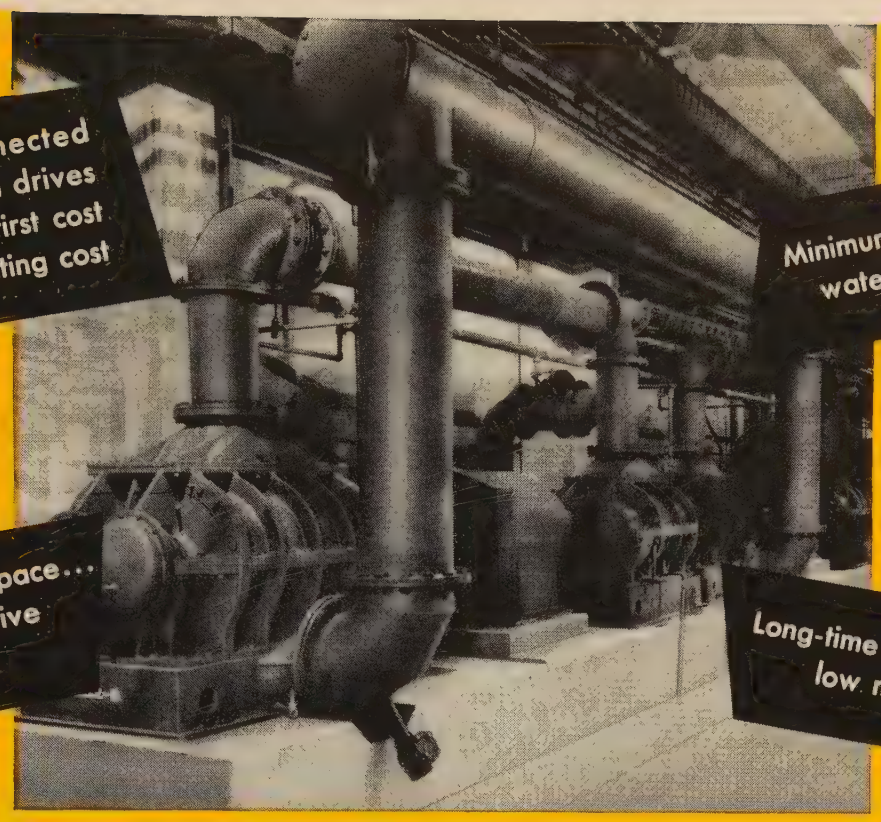
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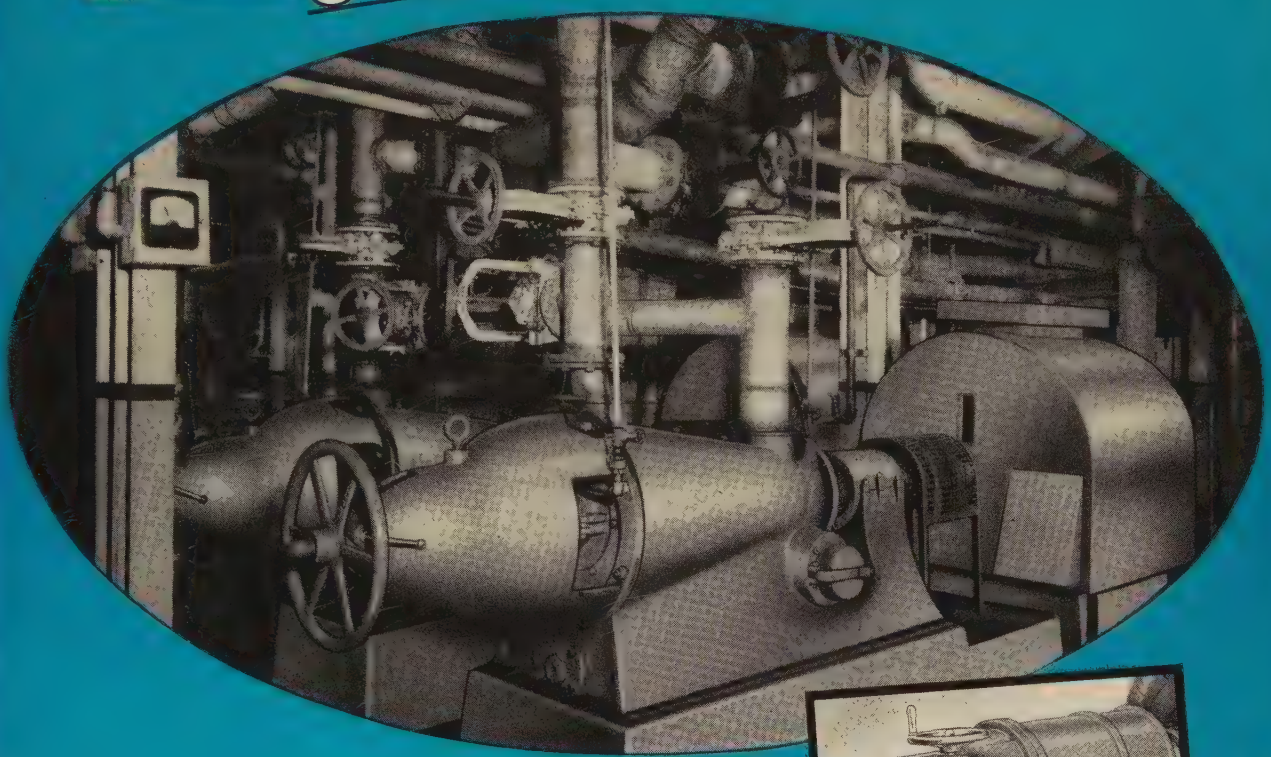

Two E. D. Jones FIBREMASTERS® installed at the Anglo-Canadian Pulp & Paper Mills in Quebec, refining Sulphite and Groundwood tailings.

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- "Per ton costs have never exceeded 60c per brightness-point."
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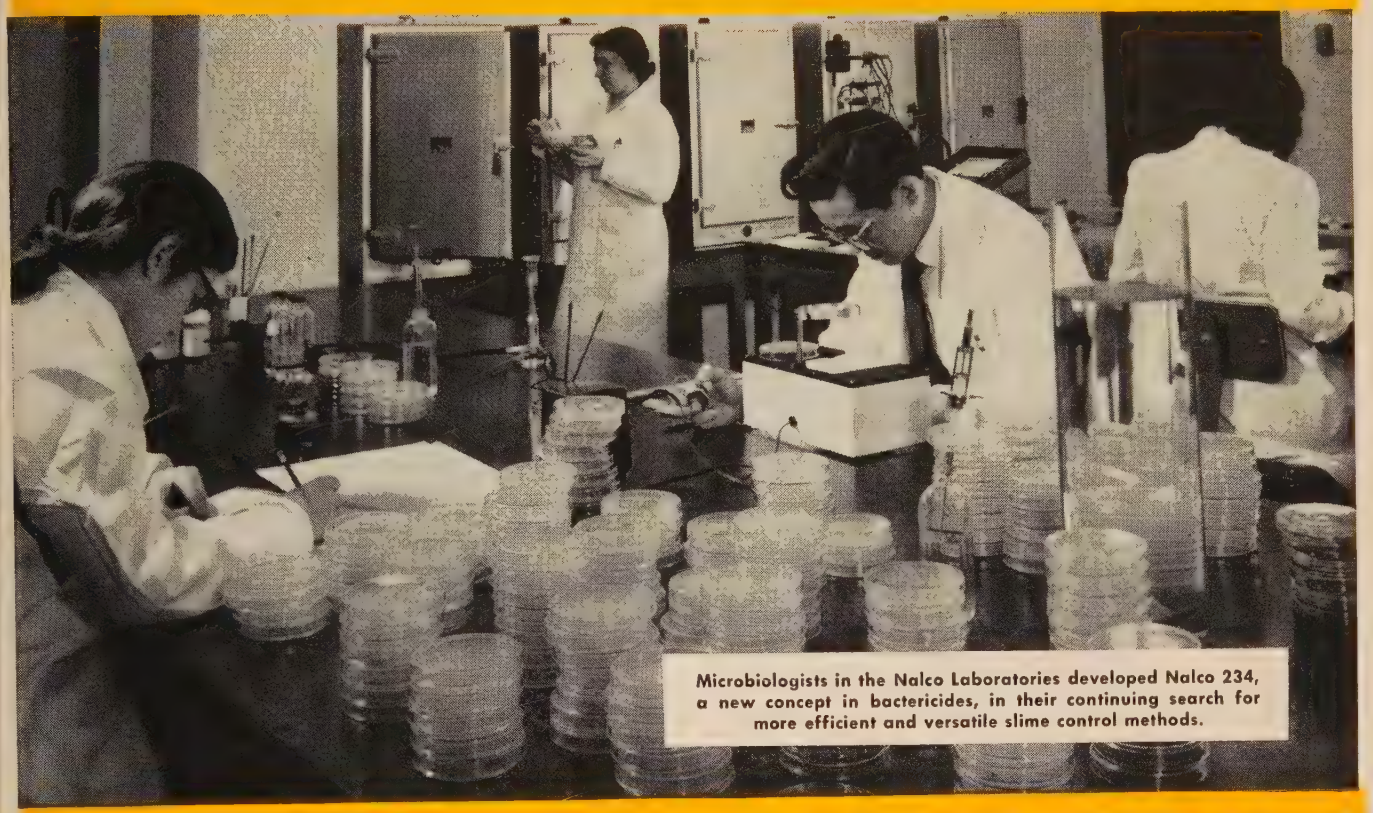

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RAW MATERIALS FOR MORE PAPER—I

FINDINGS OF AN FAO PULP AND PAPER CONSULTATION, ROME, ITALY, DECEMBER, 1952

THE general purpose of this report, which is being published in two sections, is to review the status of current practice and the application of various pulping processes to new fibrous materials. The original report (FAO Forestry and Forest Products Study—No. 6) also describes pulping procedures and tests which will allow comparisons to be made of results obtained in different laboratories, without wide duplication of effort.

The raw materials available for consideration are numerous and varied. Several pulping processes need to be considered. The choice of materials and processes for the many different grades of paper can be complicated and difficult. Confusion is sometimes added when individuals with little knowledge of the industry have to make decisions, especially when widely different advice is given by experienced authorities. Sometimes even more confusing are the claims of inventors and promoters of new and untried processes.

In the program undertaken by FAO there has been urgent need for providing answers to such questions as:

1. What are the possibilities for manufacturing pulp and paper from the various kinds of raw materials available?
2. What processes should be used, and for what kinds of paper?
3. If the use of new materials is technically possible, is it considered to be a feasible commercial venture?
4. What are the comparative manufacturing costs?

It was with these questions in mind that FAO convened a meeting of pulp and paper specialists in Rome in December, 1952.

I. FIBROUS RAW MATERIALS IN CURRENT USE FOR PULP AND PAPER

Since estimates of the possibilities of using new materials[1] must be made on the basis of past experience, it is important to review current industrial practice, particularly with regard to broadleaved woods, straw, bagasse, bamboo, and other fibers which constitute the bulk of fibrous materials available.

Conifers

It is important to realize that coniferous softwoods are used for 85 to 90% of world pulp production. They are used almost entirely for the products in greatest demand—newsprint, kraft wrapping paper, and kraft paperboard. This large proportional use of conifers has not changed greatly for many years in spite of the great expansion in pulp and paper manufacturing capacity that has taken place in North America and Europe since World War II. A few untapped sources of conifers still remain in the Rocky Mountains of North America, in Canada, and in Alaska. Probably the largest remaining stands are in the U.S.S.R. There are others in Central and South America, Oceania, and Asia. Even with full development of the present and potential coniferous wood sources, however, it appears unlikely that they could supply the future requirements for pulp and paper all over the world. There are, indeed, many countries which have no conifers.

[1] For the purposes of this report "conifers" are taken to include all members of the *Coniferae* (firs, pines, etc.)—often referred to as softwoods—and "broadleaved woods," those species which belong to the *Dicotyledoneae*—often referred to as hardwoods.

Broadleaved Woods

The fact that conifers have maintained their predominant position in current usage has tended to obscure the developments that have taken place in the use of broadleaved woods and other fibrous materials in recent years. Their share in supplying growing requirements has been maintained and increased slightly by more than an expansion of earlier usage. Broadleaved woods and plant fibers are now being used for other processes and products in addition to those established earlier.

In the United States, for example, where broadleaved woods are available in most forest regions, approximately 4 million cords[2] (10.02 million cu. m. solid vol.) of these woods were used in 1951. This is more than four times the amount used before 1940. In further expansion of mill capacity now planned in the Southern States, where pine has been used almost exclusively, it is reported that broadleaved woods will supply about one third of the new wood requirements. Nearly $2^1/_2$ million cords (6.4 million cu. m. solid vol.) of broadleaved woods would be required annually for this purpose alone. This and many other instances of present-day usage furnish ample evidence that today broadleaved woods can be considered a feasible raw material base for the expansion of the pulp and paper industry. Until recent years this was not generally true.

United States. In the years before 1940 in the United States broadleaved woods were used mainly for soda pulp for printing papers. Today they are used in considerable quantities for all of the conventional pulping processes and in rapidly increasing amounts for the newer semichemical processes. Accurate data on the use of broadleaved woods for the different pulping processes are not available. A very rough approximation is indicated as follows:

	Cords, thousands	*Cu. m. solid volume, thousands*	*Per cent*
Soda	1000	2550	25.6
Sulphate	500	1275	12.8
Sulphite	700	1785	18.0
Groundwood	700	1785	18.0
Semichemical	1000	2550	25.6
Total	3900	9945	100.0

Various species and mixtures of broadleaved woods are used for soda pulp. These include birch, beech, maple, aspen,[3] tulip poplar, various species of oak, and others that may be readily available. Although practically all of the available species may be pulped satisfactorily by the sulphate process, birch, aspen and gum are preferred. Oaks and other woods are also used in some quantity. Because their strength is lower than that of coniferous sulphate pulps, they are not used as a principal fiber in kraft papers of the conventional

[2] One cord pulpwood (128 cu. ft. gross vol. or 90 cu. ft. solid vol.) = 2.55 cu. m. solid vol. or 3.50 cu. m. gross vol.

[3] *Populus tremuloides* and *P. grandidentata.*

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type. They are used blended with other pulps for printing, bond, tissue, and other types of paper.

Broadleaved sulphite pulps are made principally from aspen and birch. The pulps are used in printing, bond, tissue, miscellaneous grades, and as high alpha-cellulose pulps.

Practically the only broadleaved wood used in the United States for groundwood pulp at the present time is aspen. Aspen groundwood is used mostly in printing papers and tissues.

Increasing wood costs—together with its suitability for pulping broadleaved species—account for a wide interest in high yield semichemical pulping. The daily capacity for the manufacture of semichemical pulp in the United States had by 1951 risen to 2750 tons. Although most of the semichemical pulp now manufactured in 26 mills is used for making corrugating container boards, there is a substantial production of bleached semichemical pulp in a few mills for bond and printing papers. In this latter case the semichemical pulp is normally blended with other fibers.

With very few exceptions pulps from broadleaved woods are used in blends with longer fiber pulps. Some corrugating boards are made from 100% semichemical pulp. Although some grades of paper not requiring high tear can be made from semichemical broadleaved pulps alone, it is difficult to meet present standards for many grades of paper without the admixture of some longer fiber pulps.

Broadleaved woods are used most extensively in regions where the conifer supplies are most limited. In 1949 in the Appalachian (U. S.) region 57% of the 926 thousand cords of pulpwood consumed in the region consisted of broadleaved wood. In the Lake States region they accounted for 25% of the 611 thousand cords used. In the northeastern region 579 thousand cords were consumed, 17% being broadleaved woods.

Australia. More than 100,000 tons of pulp are manufactured annually from broadleaved woods (eucalypt species) in Australia. This is an even greater proportion of the total pulp used as compared with the United States. The use of eucalypt groundwood in 78% of the furnish of newsprint, the use of eucalypt kraft pulp in printings, wrappings, and some container type boards (in quantities of 40 to 80% of total furnish) and the use of an average of 90% eucalypt soda pulp in fine printings and writings are now well established. Eucalypt soda pulp is also used in the base for coated papers. *Eucalyptus regnans* is the only species which has produced groundwood pulp satisfactory for newsprint, and in Australia only old trees, i.e., about 300 years old, can be used.

In *South Africa* eucalypts and wattle (*Acacia mollissima*) have been used for bleached sulphate pulp manufacture for several years and comprise 65 to 90% of the furnish of printing, writing, and envelope grades of paper.

Eucalypts are also used for groundwood pulp in *Chile* and in *Brazil.*

In *Italy* approximately 67% of the groundwood pulp manufactured in 1950 (123,000 tons) was made from poplar.[4] Imported and native spruce and fir accounted for the remaining 33%. Much of the aspen groundwood was used for newsprint. Beech is used for rayon grade sulphite pulp.

In *Germany* beech is used for sulphite pulp, both for paper and for rayon.

In *Spain* and *Portugal* eucalypts are used in small quantities for sulphite pulp in the manufacture of a variety of papers.

In *Sweden* bleached sulphite pulps made from aspen and birch are used in printing paper. Bleached sulphate pulps are made from broadleaved species (birch) for use in fine papers where higher strength is required.

Present trends would indicate that coniferous softwoods will continue to be used to the fullest extent of their availability, but that broadleaved woods and other fibrous plants will be consumed in even greater quantities where this can be done economically. The kinds of material and processes will be determined by their availability, cost, and other local factors.

[4] Mainly hybrids between European poplars (*Populus nigra*) and American poplars (*P. deltoides*).

Nonwood Materials

Although many of these have been used for several years in a number of relatively small mills scattered over the world the scarcity of pulpwood has brought about a new interest in these materials. Those used on an industrial scale are briefly mentioned below.

Straw. Straw is used more extensively than the other materials and its commercial development has advanced in many countries, especially in Europe. Coarse pulps for corrugating board, solid fiberboard, and low quality wrapping papers are produced by lime processes. In some instances, however, soda and monosulphite processes have been used to give improved quality. Bleached pulps for fine papers are manufactured by soda, caustic soda–chlorine, sulphate, and monosulphite processes.

Esparto. This grass which occurs in southern Spain and northern Africa has been used for the manufacture of fine papers for nearly 100 years. This still represents the largest volume of grass used for the manufacture of paper. Soda processes are generally used for pulping.

Sabai. Sabai grass (*Eulaliopsis binata*), pulped by a soda process represents about 22% of the fibrous raw materials used in the paper industry in India. High quality papers are made from these pulps.

Bagasse. Sugarcane bagasse, while not used extensively, can be pulped by processes used for straw to produce pulps of essentially the same quality. The quality of such pulps can be improved by the removal of pitch cells. Papers and and boards of various grades including high quality printing and writing papers are manufactured from bagasse pulps.

Bamboo. Bamboo, used to the extent of about 60% of the fibrous raw materials in India (225,000 tons in 1951), is pulped by sulphate processes, usually the two-stage process. In one mill magnesium bisulphite is used for the manufacture of pulp. Good wrapping and high quality writing and printing papers are made from bamboo pulps.

Seed Flax Tow. Practically all cigarette paper today is manufactured from the tow of seed flax straw. In addition fine book, condenser, and other papers are made from this bast fiber. A soda sulphur process is used to prepare these pulps.

Manila Rope. This raw material is pulped for use in making flour, cement, and other bags which must possess high tear resistance. Others of the hard fibers possess possibilities for such use in specialty paper manufacture. This material is pulped by the soda process.

Technical Feasibility of Broadening the Raw Material Field

As would naturally be expected, the technical feasibility of using new materials in laboratory scale demonstrations has advanced beyond commercial practice. Numerous publications on the subject are available. It is not possible to review all of them here, but some examples can be cited. Many species of temperate broadleaved woods, for example, have been used to make experimental newsprint of good quality from various blends of groundwood, sulphate, and semichemical pulps, usually with some quantities of coniferous wood pulps. Bond, printing, tissue, and other kinds of paper have been made from a number of broadleaved species. Blends of broadleaved and coniferous pulps have been used for experimental liner board and wrapping papers.

Broadleaved semichemical pulps from many species both unbleached and bleached have been tried in many kinds of paper. Encouraging results have been obtained by softening

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chips by a very mild treatment in cold caustic soda and refining them in a disk mill to produce groundwood-type pulps from broadleaved wood. The heavier species as well as those of low density have produced relatively strong and free pulps by this method. Their use in newsprint trials has been encouraging. Some quantities of cold soda pulps made from aspen have been used commercially for corrugating board. Impregnation of wood blocks and digestion before grinding, as in the Chemigroundwood process, produces relatively strong pulp from broadleaved woods.

Similarly, straw, bagasse, and other materials have produced good quality pulps for use in many kinds of paper. Blends of pine kraft with straw or bagasse pulps have been used for liner board. Newsprint has been made substituting these pulps for sulphite in the conventional groundwood-sulphite furnish and in combination with wastepaper as well. Pulps prepared at low temperatures (about 90°C.) in an alkaline liquor in a hydrapulper or similar equipment—and commonly referred to as mechano-chemical pulps—are of excellent quality and obtainable in yields up to 60% with low chemical cost.

A particular example of pulping investigations that have been conducted on new materials is the work conducted in France on tropical broadleaved woods from French Africa. Pulping investigations in the laboratory were followed by an appraisal of the feasibility of pulp manufacture, which is presented later in this publication as part of a "case history" on tropical broadleaved woods.

Other examples could be given but the application of current practice and additional information now available undoubtedly demonstrate the technical possibility of making many grades of paper from many new materials. The actual feasibility of their use, however, can only be determined in most instances by economic factors. It should be recognized that apart from the technical difficulties—and these are often formidable—the hard economics of pulp and paper production in places remote from large consuming centers often preclude immediate development of even the most promising materials. Thorough investigation on the ground combined with expert examination of such important matters as water supply, effluent disposal, and other essential requirements, all need the most careful assessment before it is possible to think in terms of a pulp project.

II. PULPING PROCESSES FOR WOOD

Before the raw material may be converted into pulp, there are important operational steps which are necessary and which have not been included under any of the process descriptions which follow. These are briefly discussed below:

Wood Handling. It is not possible to estimate investment and operating costs for storing and reclaiming wood from storage because of the wide variety of conditions encountered and the degree of mechanization. In well laid-out and mechanically equipped storage yards in North America the cost of handling wood to and from storage will vary from $0.25 to $1.00 per cord.

Barking and Chipping. For all but the coarsest grades of paper the normal practice is to remove the bark and dirt from the wood before further processing. Various methods are in use such as handbarking, mechanical (barking drums), and hydraulic barkers. Development of the latter has made rapid strides and types are available for various sizes of wood, including slabs. They are not satisfactory for cleaning dried and checked wood. An example of the investment cost for wood preparation for a 100-ton chemical pulp mill in the United States, including barking chipping, and accompanying operations, is $4000 per daily ton. Ten men would be required, or 0.8 man-hour per daily ton of pulp. This includes barking and chipping the wood, but not the wood handling cost referred to above. Losses in these operations will amount to 3 to 10% of the weight of the wood.

Recent development in North America has indicated that it may not be necessary in the case of coarse pulps and bleached alkaline pulps from broadleaved woods to remove the bark prior to pulping. By this method bark specks and wood dirt remaining in the pulp after digestion can be removed by centrifugal means, thus recovering fiber from the bark and avoiding the wood loss which normally occurs in the barking operation. Obviously the effectiveness of this method would have to be carefully checked in relation to the type of wood and process used.

Process Water. In some instances both quantity and quality of the water available may be the deciding factor in determining the location of a mill. It is entirely possible that an elaborate water treatment plant will have to be built in most cases, particularly where bleached pulps are to be produced.

Chemicals. Provision will have to be made for handling and storing the required chemicals, and in some instances it may be desirable or even essential to manufacture these on the site. The production of chlorine and caustic soda by the electrolysis of salt is a case in point and would involve a sizable investment.

The pulping processes which may be used for making various kinds of paper from different raw materials are determined primarily by their suitability for both raw materials and end products. To gain a better conception of the applicability of the processes available it is desirable to review in detail these factors and others that may be pertinent to their operation. This review is given in summary fashion for each process.

It should be noted that in the discussion of each process under the heading "Operating Data" the figures shown for investment, labor, etc. include only the operations involved after the wood is chipped or otherwise prepared for processing, and carry through to the "slushed" pulp stage. The operations and cost involved in the "raw material handling" section above, and, in converting the slushed fiber to sheeted pulp or to paper, must be considered separately. The figures do not include such factors as power development, office or sales expense, forestry management, research, or other overheads. The investment costs are approximate only and based on practice in industrialized countries.

The minimum mill size indicated in the following description of each process should be considered as rough estimates only since local conditions will often be a controlling factor.

Groundwood

The groundwood process consists of forcing wood against a grindstone running in water showers and partly submerged in a mass of pulp. Since the process is entirely mechanical, close to the maximum efficiency possible in wood conversion is attained.

Uses

This pulp, because of its low cost, is widely used in papers where high strength, high brightness, and high brightness stability are not important factors. Normally it is blended with other pulps possessing higher strength characteristics. Its use imparts opacity, bulk, and good printing qualities to the sheet, and its drainage characteristics can be controlled to allow high paper machine speeds in such grades as newsprint.

Newsprint normally contains 75 to 85% groundwood when its production is based largely on coniferous woods. If woods from broadleaved species are used to any appreciable extent, it may be necessary to increase the percentage of strengthening fiber, the groundwood percentage being correspondingly reduced.

Other uses include catalog, magazine, coating, and other printing papers (50 to 85% groundwood content) wallpaper, specialty board, tissue, and low-grade wrapping.

The steamed groundwood process in which the logs are

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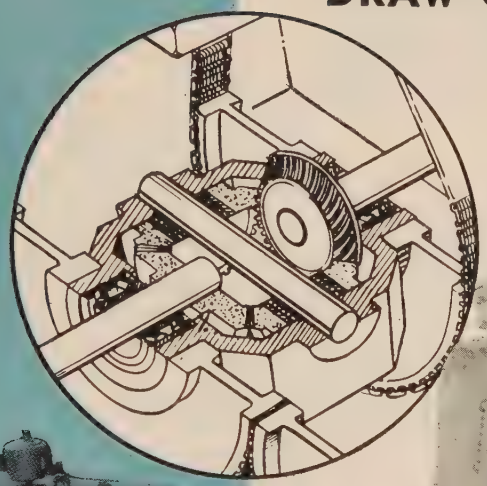

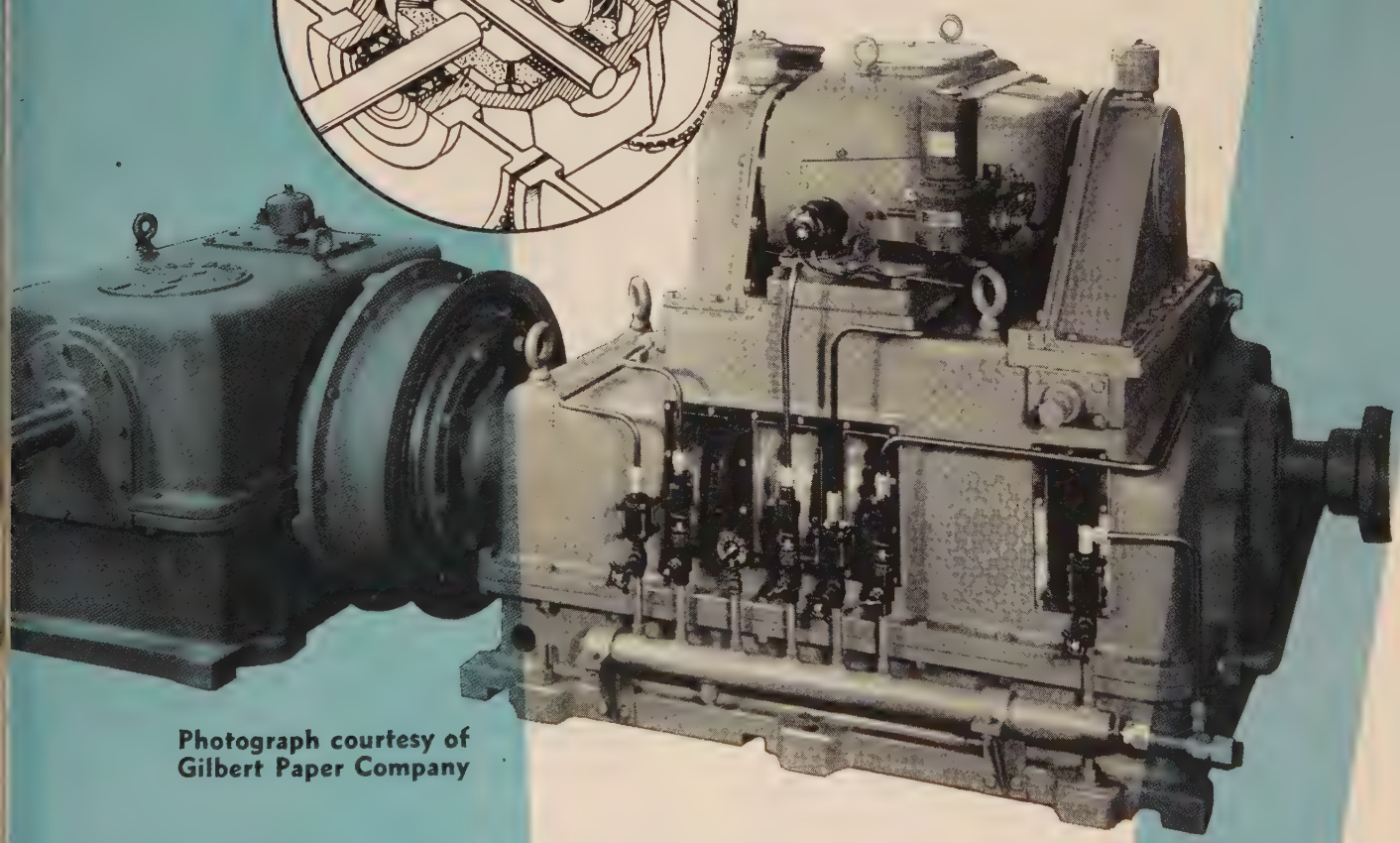

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steamed before grinding, provides a stock having considerably higher strength than the ordinary groundwood process. The pulp, however, is darker and its production requires steam and more labor. On the other hand, power requirements are lower.

Steamed groundwood is used for boards and—according to strength requirements—can be added to the furnish for coniferous wood unbleached kraft papers.

Species Suitable

Conifers. Spruce (*Picea*), fir (*Abies*), hemlock (*Tsuga*), some species of pine (*Pinus*), and other light-colored coniferous woods are suitable. Pines and other resinous species are less desirable than spruce or fir, in some cases only young trees, in which heartwood has not developed, may be used. Some species of pine, for example lodgepole and Monterey, produce better quality groundwood than others. Grinding conditions must be varied for different wood species and for different end-use requirements.

Broadleaved Species. Broadleaved species are generally considered less desirable than coniferous woods. Poplar, including aspen, in varying percentage with conifers is used extensively in the United States, Canada, France, and Italy for newsprint and other printing papers. Low grinding pressure and dull stone surface is preferred. *Eucalyptus regnans* groundwood is used for newsprint in Australia and only old trees (about 300 years) are satisfactory. Other species of eucalyptus are used in Brazil and Chile. Other light-colored low and medium density broadleaved woods may be suitable for groundwood pulp.

High density broadleaved wood species are generally considered unsatisfactory since they tend to produce flourlike pulp having very low strength. Groundwood pulp made from certain of the heavier broadleaved woods may, however, be used in small quantities in blends with stronger pulps, but this use is not normally considered feasible except in special circumstances. Most tropical broadleaved woods, because of their density, extractives content, and color, are not suitable.

Bleaching

Peroxide. Sodium peroxide, after partial removal of free alkali with sulphuric acid, and in the presence of sodium silicate and magnesium sulphate, will increase the brightness of many coniferous and broadleaved groundwood pulps to about 70 to 73 (General Electric), when used to the extent of approximately 2%, on the weight of moisture-free pulp. Whereas this brightness is considerably lower than that of fully bleached semichemical or chemical pulps, it is quite adequate for some grades such as certain printing papers. Increasing the quantity of peroxide above 2% normally does not further increase brightness. The lignin is not removed and the yield and strength of the pulp are not materially affected by this method of bleaching. With some groundwoods which otherwise do not bleach satisfactorily, a pretreatment consisting of a caustic soak followed by washing may be required.

Hydrogen peroxide may be used instead of partially acidified sodium peroxide, if brought to the same alkali content with sodium hydroxide.

The efficiency of utilization of peroxide and its rate of reaction with the pulp are somewhat dependent on the concentration of the peroxide in water, with higher concentrations being preferred. Because of the relatively high price of this reagent, a high consistency bleach is desirable. Three techniques are used in North America: (1) bleaching at consistencies of 6 to 12% such as may be obtained with standard thickening equipment, (2) bleaching at 30% or higher consistency, this being obtained with special screw press equipment, or (3) in the case of nonintegrated mills where the pulp is sheeted on a "wet machine," by spraying the peroxide solution on the sheeted pulp and allowing it to stand at room temperature for 2 or 3 days.

One-Stage Hypochlorite. Broadleaved species groundwoods will show brightness gains up to 20 points on treatment with calcium hypochlorite (10% available chlorine) when lime is added to give an initial pH of 11.5 to 12. With coniferous species the brightness gain under like conditions is normally less than 6 points.

Zinc Hydrosulphite. Brightness increases of up to 6 or 8 points are obtained with 0.5 to 1.0% zinc hydrosulphite. Although this is not as great a brightness increase as is obtained with many woods when using peroxide or hypochlorite, it may be especially useful with certain woods, such as some pines, which will not show the normal brightness gains with peroxide or hypochlorite.

Operating Data[5] (per metric ton air-dry[6] pulp):

Yield from wood: approximately 95%.
Power: 1200–2000 kw.-hr. Broadleaved woods usually require more energy for grinding than coniferous woods.
Steam: no process steam required.
Water: minimum water requirements, about 15 cu. m. (4000 gal.); average water requirements, 40 cu. m. (10,000 gal.).
Labor: 1.5–2.5 man-hours per ton (basis 50-ton mill).
Minimum plant capacity for integrated mill: about 25 tons per day.
Investment: including buildings, but not including power development, $20,000–$30,000 per daily ton.
Market price October, 1952: approximately $75 per short ton (air-dry).

"Additions for bleaching (one-stage hypochlorite process):

Chlorine: 100 kg. (220 lb.).
Lime: 120 kg. (265 lb.).
Power: 30–45 kw.-hr.
Water: 55–75 cu. m. (15,000–20,000 gal.).
Labor: 0.5 man-hour (basis 50 tons/day).
Investment: $7000–$9000 per daily ton (basis 50 tons/day).

Note: As previously indicated, several techniques are available for peroxide bleaching involving somewhat different investment and operating expenses. The chemicals required would be as follows:

Sodium peroxide: 20 kg. (45 lb.).
Sodium silicate (40° Bé.): 50 kg. (110 lb.).
Sulphuric acid: 18 kg. (40 lb.).
Magnesium sulphate: 0.5 kg. (1 lb.).

Pollution (unbleached pulp basis):

Fiber loss in mill effluent: less than 1% of production.
Five-day biochemical oxygen demand (B.O.D.) of effluent: about 3 lb.[7] per daily ton production.
Minimum steam flow required to maintain dissolved oxygen above 3 p.p.m.[8] with oxygen saturation upstream:
At 15°C.—250 liters (8.7 cu. ft.) per sec. for 100 tons of groundwood pulp per day.
At 20°C.—370 liters (12.9 cu. ft.) per sec.
At 25°C.—530 liters (18.8 cu. ft.) per sec.

Semichemical Pulps

Semichemical pulps may be defined as pulps in which the fibers are separated, without material damage, by a sequence of chemical and mechanical actions in which the conditions of the separate treatments are not sufficiently severe in themselves to bring about a ready separation of the fibers. These pulps contrast on the one hand with groundwood pulps, in which the fibers are considerably damaged due to the more drastic mechanical action required for their separation, and on the other with chemical pulps, in which separation is brought about by relatively mild mechanical action such as takes place in the blowing of a digester.

[5] Detailed estimates regarding operating costs are given in Chapter V.

[6] Air-dry, i.e., 10% moist.

[7] B.O.D. (5-day test) equivalent of municipal sewage is 167 lb. of oxygen per 1000 persons.

[8] A minimum dissolved oxygen content of 3 p.p.m. is required for warm water fish; 5 p.p.m. for cold water fish.

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Chemigroundwood

This process consists of impregnation of broadleaved species logs with neutral sulphite liquor by a vacuum and pressure treatment and digestion at 140°C. for about 6 hr. before the wood is ground in a conventional type grinder. The energy required in grinding is reported to be one-half to two-thirds that of the amount for untreated spruce and the production rate is doubled. The pulp is three or four times as strong as spruce groundwood, but produces sheets that are denser and more transparent The color is darkened by the treatment. The yield is between 85 and 90%. Chemigroundwood pulps from most broadleaved species can be bleached with peroxide or hypochlorite.

Note: Up to the present time the process has had only limited development on a semicommercial scale. Until more information is available from large-scale operation, particularly regarding costs, it is not recommended at the present time for new mills.

Cold Caustic Soda

Treatment of wood chips with cold caustic soda followed be refining the treated chips in a disk mill may be considered as a method for making pulps from broadleaved wood species for newsprint-type papers. Several of these woods having both high and low densities have produced pulps which approach the quality of newsprint groundwood. This appears to be a promising method for making pulps of this type from heavier broadleaved species, which, when ground in the conventional manner, produce pulps of poor quality. Cold caustic soda pulps from most woods are darker-colored than most groundwood pulps used for newsprint. Semibleaching would be necessary in most cases to attain the brightness of conventional newsprint.

Small-scale trials have indicated that it is possible to substitute cold caustic soda pulps made from broadleaved species for about 50% of the coniferous wood groundwood in newsprint with some reduction in requirement of chemical pulp but without adverse effect on the paper quality. Newsprint made from the soft-type groundwood pulps characteristic of some of the pines may be improved by the addition of broadleaved cold caustic pulp. When cold caustic pulp is used as a substitute for groundwood in newsprint, or for the entire furnish, the sheets are likely to be more dense and the opacity slightly lower than conventional newsprint.

The only commercial operation of the cold caustic process so far has been for the manufacture of corrugating board. This operation has produced an acceptable sheet at low cost. The process is recommended for consideration, when it appears to be justified by the necessity of using high density broadleaved species for pulps of the groundwood type.

Bleaching. This pulp may be bleached with peroxide or alkaline hypochlorite. The methods, chemical requirements, and results are essentially the same as for broadleaved species groundwood pulps.

Operating data[9] (per metric ton air-dry pulp):

Yield from wood: 88–90% from temperate broadleaved species; 75–80% from tropical broadleaved species.
Caustic soda (consumed): 6–8%.
Power: 500–600 kw.-hr.
Steam: no process steam required.
Water: 55–115 cu. m. (15,000–30,000 gal.).
Labor: 2.5–4.0 man-hours (basis 50 tons/day).
Minimum plant capacity for integrated mill: 25 tons per day.
Investment: $20,000–$30,000 per daily ton.
Bleach plant: similar to groundwood.

Neutral Sulphite:

Uses. Neutral sulphite semichemical pulps (unbleached) from broadleaved species are characterized by tensile strength values approaching those of sulphate pulp from the same species. They tend to produce hard, dense sheets. Semibleached pulps have properties similar to unbleached pulps. Fully bleached pulps, however, have much higher tensile strength values, sometimes equal or superior to those of coniferous sulphite pulps.

Unbleached pulps are used mainly for corrugating board. Small amounts are used in mixtures with groundwood for specialty boards and as a substitute for coniferous wood sulphite in newsprint. Generally, unbleached semichemical pulps from light-colored species, although deficient in tearing strength, may be considered as a possible substitute for coniferous wood sulphite pulp in some products. Unbleached pulps may also be considered for use in some grades of liner board, particularly in blends with kraft pulp.

Bleached semichemical pulps are suitable for the harder types of papers. Many species produce pulps of excellent quality for glassine and greaseproof. Blended with softer pulps they can be used in printing and fine papers.

Species Suitable. Most species of temperate broadleaved woods are suitable for the neutral sulphite process. Many species of tropical broadleaved woods, however, have high lignin content or high extractives and are not well suited to this process. Light-colored woods are necessary for light-colored unbleached pulps and in some instances for bleached pulp. Coniferous woods are considered less desirable because of their higher chemical consumption in cooking, high lignin content for a given yield, and high energy requirement for refining.

Bleaching. For 65 to 75 brightness either a one-stage hypochlorite bleach or sodium peroxide treatment can be used. Such treatment usually results in only minor loss in yield, since the lignin remains in the pulp. Hypochlorite bleaching is carried out as described for groundwood pulp, with the addition of 2% sodium silicate. Slightly better results may be obtained by the substitution of equivalents of sodium hypochlorite and sodium hydroxide for the calcium hydrochlorite and calcium hydroxide previously described for groundwood. Peroxide bleaching may also be used according to the procedure discussed under groundwood, but with the addition of 6% sodium silicate.

For 80 brightness, or higher, essentially complete delignification is required, resulting in a material reduction in pulp yield. A three-stage treatment comprising chlorination, alkaline extraction, and hypochlorite oxidation has been found to be satisfactory. The lignin content of the unbleached pulp should be about 11% or less to avoid excessive chlorine consumption.

The total chlorine requirement is approximately 1.4 times the lignin content of the pulp.

Operating data.[10] (per metric ton air-dry pulp):

Broadleaved woods:

Unbleached pulp yield: 70–85%.
Bleached pulp yield: one-stage treatment for low brightness: 67–82%.
Three-stage treatment for high brightness: 55–60%.
Sodium sulphite: 10–20% of moisture-free wood.
Sodium carbonate: 2–4% of moisture-free wood.
Power: 300–400 kw.-hr.
Steam: 2.00 tons (4400 lb.).
Water: 55–115 cu. m. (15,000–30,000 gal.).
Labor: 2.5–4.0 man-hours (basis 50-ton mill).
Minimum plant capacity for integrated mill: 25 tons per day.
Investment: $35,000–$45,000 per daily ton (basis 50-ton mill).
Market price October 1952: semichemical pulp is largely made in integrated mills and only very small quantities are sold as market pulp. No North American market price has been established.

Note: Corrosion-resistant digesters should be used.

"Additions" for bleaching:

(a) *One-stage hypochlorite:*

See data for groundwood. To the chemical cost add the

[9] Detailed estimates regarding operating costs are given in Chapter V.

[10] Detailed estimates regarding operating costs are given in Chapter V.

HIGH WET-STRENGTH FOR ALL PULPS AT LOW COST—WITH UFORMITE 711

UFORMITE 711 gives high wet-strength to a wide variety of pulps, bleached and unbleached, ranging from kraft to sulfite-groundwood combinations. Because of its high efficiency, its cost is low. As little as 0.5 percent gives good wet-strength; 3.0 percent gives maximum values.

And that's not all. This cationic resin improves dry tensile, Mullen, fold, pick resistance, and wet rub in a variety of paper products. It's easy to use as supplied—without complicated mixing procedures. No acid or aging is necessary. Add it preferably at the head-box, although earlier addition is feasible. Broke recovery is easy.

Technical literature and a sample of UFORMITE 711 are yours upon request. For detailed recommendations, write us about your wet-strength problem.

CHEMICALS FOR INDUSTRY

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cost of 20 kg. (45 lb.) sodium silicate (40° Bé.). If a soda bleach is used instead of a lime bleach, 85 kg. (190 lb.) caustic will be required, taking the place of 120 kg. (265 lb.) of lime shown for groundwood bleaching.

(b) *Three-stage bleaching:*

Chlorine: 160 kg. (350 lb.) per metric ton unbleached pulp.
Sodium hydroxide: 20 kg. (45 lb.) per metric ton unbleached pulp.
Lime: 8 kg. (18 lb.) per metric ton unbleached pulp.
Power: 45–75 kw.-hr.
Steam: 0.4–0.6 ton (900–1300 lb.).
Water: 170 cu. m. (45,000 gal.).
Labor: 0.5–1.0 man-hours (basis 50 daily tons).
Investment: $9000 per daily ton.
Minimum plant capacity: 50 tons per day.

Pollution:

Fiber loss in mill effluent: 2–3% of production.
Five-day B.O.D. of effluent: 64 kg. (140 lb.) per daily ton of production.
Minimum stream flow required to maintain dissolved oxygen above 3 p.p.m. (for plant with 100 ton daily capacity):
At 15°C.—10.6 cu. m. (374 cu. ft.) per sec.
At 20°C.—15.7 cu. m. (555 cu. ft.) per sec.
At 25°C.—22.9 cu. m. (808 cu. ft.) per sec.

Recovery of Heat and Chemicals from Spent Liquor. Most neutral sulphite semichemical mills are at present operating without heat and chemical recovery. However, a form of recovery is practiced in cases where the mill is jointly operated with a sulphate mill, where the residual liquors from the two processes are combined and subsequently evaporated and incinerated in the sulphate mill recovery system.

Operating in this manner the sulphur and soda recovered from the semichemical liquor replace salt cake normally used in making up the sulphate liquor to replace the recovery losses. In the combined operation, however, the amount of spent semichemical liquor that can be used is limited by the size of the sulphate mill and its recovery efficiency. The maximum capacity of the semichemical mill in such a combination is normally about 25% of the sulphate mill capacity.

The problem in recovering chemicals from neutral sulphite semichemical liquors for reuse in the semichemical mill is essentially that of converting sodium sulphide (Na_2S) to sodium sulphite (Na_2SO_3), since the smelt obtained in burning consists largely of sodium carbonate (Na_2CO_3) and sodium sulphide (Na_2S), The sodium carbonate is easily converted to sodium sulphite by treatment with sulphur dioxide, but the sodium sulphide forms sodium thiosulphate ($Na_2S_2O_3$) and other compounds.

Various methods for conversion of sodium sulphide to sodium sulphite for reuse in the same process have been proposed, but with one exception no satisfactory commercial-scale operation has yet been reported. In one mill in Sweden operating on the related bisulphite process and using a sodium-base liquor, a successful recovery method is in operation. In this method sodium-base bisulphite liquors are evaporated and burned. The sodium sulphide is converted to sodium sulphite by treatment with carbon dioxide followed by sulphur dioxide. It is probable that such a procedure could be applied to neutral sulphite semichemical liquor.

A number of extensive investigations of this problem are being conducted by various mills and other organizations. Some of them are variations of the carbon dioxide treatment. Others are based on direct oxidation of the sulphide to sulphite at controlled temperatures and moisture contents. Other methods employ ion-exchange principles avoiding evaporation and burning. Another novel approach also avoids evaporation and burning by achieving oxidation in solution at a high pressure at a moderate temperature. Some of these investigations have progressed to the pilot-plant stage. In the opinion of many individuals in close contact with this work there are strong possibilities that a practical solution may be found in the next few years.

Sulphate Semichemical

Uses. Except for their dark color, sulphate semichemical pulps from broadleaved woods are similar to neutral sulphite pulps, but have slightly lower strengths. Such pulps are suitable for corrugating board and in some grades of liner board.

Manufacture of sulphate semichemical pulps from broadleaved species would ordinarily be considered only as a part of a conventional sulphate mill operation, manufacturing other grades as well. The process is not used extensively but should be considered in an integrated operation for the manufacture of a suitable combination of products. Whereas the neutral sulphite semichemical process has been applied only to broadleaved woods—at least up to the present time—it has been found that coniferous wood sulphate semichemical pulps are suitable for the manufacture of corrugating liner board and other related grades. This gives an economic advantage inasmuch as high yields (up to 65%) may be obtained, and the process can be operated, with only minor modification, in the standard sulphate pulp mill with standard recovery operations. In this modified process the digestion is carried out under conditions of milder temperature and shorter time, and with lower chemical content, than are normally used for manufacturing sulphate chemical pulps. The softened chips resulting from digestion do not disintegrate on blowing, disintegration being accomplished by "hot refining" with a disk mill prior to the separation of the fiber from the liquor.

Species Suitable. (1) broadleaved species and (2) coniferous species.

Operating Data. Wood and water requirements, energy for refining, and labor are similar to those required for neutral sulphite. Other factors such as chemical recovery would be similar to conventional chemical sulphate, but the balance between steam generated and steam consumed would have to be more clearly determined in each specific case.

Chemical Pulps

Chemical pulps may be defined as those pulps obtained by digestion of wood or other fibrous materials with chemical reagents to a point where the fibers are largely separated one from the other during the blowing or washing out of the digester. They are obtained from wood in yields of about 45 to 55% depending on species; yields may be lower in the case of some agricultural residues.

Sulphate

The sulphate process is of special importance in the pulp and paper industry since, when properly applied, it allows:

1. A relatively high pulp strength, particularly in resistance to tear, for any given wood species.
2. A maximum flexibility with regard to species, inasmuch as the process is suitable for most fibrous materials such as wood, straw, etc., that are available for producing pulp.
3. A maximum flexibility, when compared with other processes, with regard to end-use since, by suitable choice of raw materials and bleaching of the resultant pulps, most grades of paper can be exclusively or largely made up from such pulps, assuming that their use can be justified from the cost standpoint.
4. Recovery by well-developed processing which involves evaporation and incineration of the residual nonfibrous portions of the plant material contained in the residual liquors. Also simultaneous recovery of digestion chemicals and steam required for digestion on the one hand, and minimization (but not elimination) of stream pollution problems on the other.

Major disadvantages of the sulphate process include:

1. The high capital cost involved in the construction of plant.
2. The disagreeable odor of hydrogen sulphide, mercaptans, etc., normally associated with this operation. (Considerable strides have recently been made in minimizing this nuisance factor, and special attention should be given to this aspect in the design of new mills.)
3. The brown color of the unbleached pulps necessitating semibleaching or bleaching for printing and similar grades.

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the Impco barker

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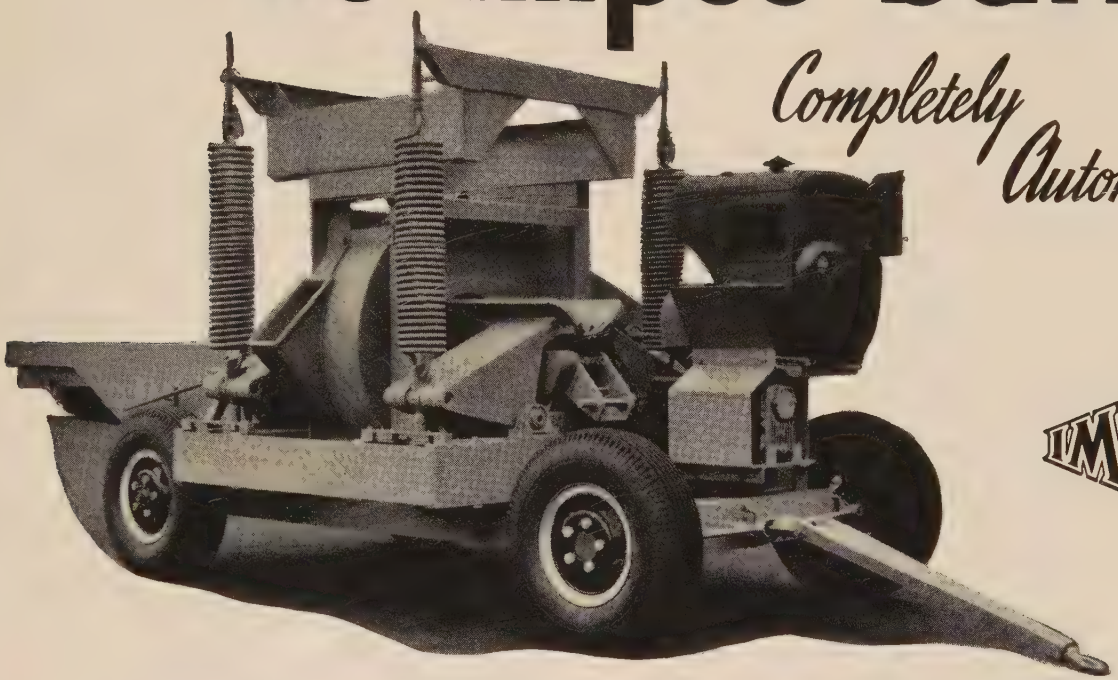

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Capacities up to 20 cords per hour depending on conditions, size and type of wood can be expected.

Specifications:

Wood size—
4′ to 8′ in length, 4″ to 18″ in diameter
Feed Rate—
30 to 120 f.p.m.
Infeed and Outfeed Conveyors—
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F 1-a

It should be noted that whereas the sulphate mill is adapted to many species, it does not necessarily follow that any given combination of species may be processed simultaneously, and for a different class of end-use in the same mill, unless a "split system" is installed. This latter would involve separate digestion and fiber processing systems with a common liquor recovery system.

When applied to coniferous wood the sulphate process is often termed the "kraft" process and the pulps produced are termed "kraft" pulps. This latter term normally refers only to coniferous wood pulps, and those produced from broadleaved species should be described as "broadleaved sulphate pulps" or more commonly as "hardwood sulphate pulps."

Whereas the sulphate process was initially so termed inasmuch as sodium sulphate (salt cake) was used as chemical make-up, many mills are at present using other sodium and sulphur compounds for this purpose. These include those mills adding caustic soda and sulphur to the white liquor at the digester or adding residual liquor from a neutral sulphite semichemical pulp mill to the black liquor, etc.

The digestion liquor of a sulphate mill contains a mixture of sodium hydroxide and sodium sulphide as digestion reagents in contrast to the conventional "soda mill" liquor which contains only sodium hydroxide.[11]

The superiority of the sulphate process to the soda process lies in the sulphidity of the cooking liquor, which accelerates the delignification reaction, thus resulting in higher yield with less cellulose degradation and therefore better strength properties of the pulp. Heat and chemical recovery are normally considered essential for economic production. The chemicals are regenerated, and the loss is replaced by salt cake or sodium hydroxide and sulphur. For unbleached pulp the amount of heat recovered in modern mills efficiently operated may be sufficient for all the heat requirements, including drying and other uses. The use of corrosion-resistant materials for the digesters should be considered. Sulphate pulps normally require more bleach reagent and a more complex bleach plant than is required for a sulphite mill.

For proper bleaching of sulphate pulps a five to seven-stage system is normally required. When bleaching to the same degree of brightness as sulphite pulps (about 85), the use of chlorine dioxide or peroxides at one or more stages is often necessary.

In general, the semibleached grade having a brightness of about 70 can be produced from broadleaved pulps in one stage with 4 to 6% available chlorine applied as calcium hypochlorite. A two or three-stage process is usually necessary to produce the semibleached grade from coniferous pulps with 4 to 7% chlorine.

Uses. Coniferous sulphate pulps are characterized by high strength and the unbleached pulps have been widely used for kraft, bag paper and wrappings, condenser paper, kraft liner, and container board. Since it has become possible in the last 15 years to bleach sulphate pulps satisfactorily their use has been materially increased. Semibleached pulps are substituted for unbleached sulphite in newsprint. Bleached sulphate pulps, in blends with other pulps, are used for book, printing, bond, writing, tracing, and other fine papers.

The use of this process with broadleaved species is becoming of increasing importance, and it would appear that such pulps—when prepared with a minimum of degradation—will be found suitable for many grades where coniferous pulp had been considered essential, as well as in printing grades, etc., where soda pulps have been used previously.

[11] Many soda mills add small amounts of sulphur to the system, this giving low concentrations of sodium sulphide. A differentiation was given in the textbook jointly prepared by TAPPI and CPPA Committees: "Pulp and Paper Manufacture," Vol. I, page 366, 1950, McGraw-Hill, New York, which recommended that those mills using liquors in which the sulphidity (i.e., sulphide as a per cent of sulphide plus caustic) is in the range of 15 to 30% or higher be termed sulphate mills, and those with sulphidity values of about 5% or less be termed soda mills. Normally the bleached chemical pulps produced in the sulphate mills as so defined are materially stronger than those produced in soda mills and which are termed soda pulps.

Conventional sulphate pulps are not suitable for dissolving purposes. After prehydrolysis, however, they react well in the viscose process and are considered to produce a yarn of highest quality. Extensive research has been under way for many years all over the world to increase the suitability of ordinary sulphate pulps for such purposes.

Species Suitable. As previously indicated, this process is suitable for most woods, including pines and Douglas-fir and many tropical broadleaved woods, which cannot be pulped satisfactorily by the sulphite process. The yield varies with the chemical composition of the wood. The sulphate process has a high tolerance to partially decayed wood and bark, although with the latter special cleaning is normally required for high quality pulps.

By-products. The crude tall oil, separated from the black liquor, can be refined to fatty acids, soaps, and resins. Sulphate turpentine may be obtained in the condensate from the relief gases. The yield of these products varies greatly with the amount of quality of the resin of the wood, and with many species this recovery is not economic. The possibility of recovery of lignin for use as a resin in plastics, or as a strengthening agent for rubber, would appear to hold promise for the future.

Operating data[12] (per metric ton air-dry pulp):

Yield from wood: *conifers*—45 to 50% for unbleached pulp; 40–45% for bleached pulp; *broadleaved species*—50–55 for unbleached pulp; 48–53 for bleached pulp (varies with species and pulp quality).
Salt cake: 70–160 kg. (150–350 lb.), or the equivalent in sodium hydroxide and sulphur.
Lime: 10–45 kg. (25–100 lb.); lime kiln used.
Power: 225–400 kw.-hr.
Steam: self-sustaining;[13] approximately 9000 lb. per ton used and 10,000 produced in alkali recovery.
Water: 75–130 cu. m. (20,000–35,000 gal.).
Labor: 3.0–6.0 man-hours (100-ton mill basis).
Investment: about $55,000–$65,000 per daily ton of unbleached pulp (100-ton mill basis).
Minimum plant capacity: approximately 100 tons per day.

"Additions" for bleaching (80–85 brightness):

Chlorine: 60–100 kg. (130–220 lb.) for coniferous woods; 50–80 kg. (110–175 lb.) for temperate broadleaved woods.
Sodium hydroxide: 30–40 kg. (65–90 lb.).
Lime: 20–35 kg. (45–75 lb.) for conifers; 13–27 kg. (30–60 lb.) for temperate broadleaved woods.
Power: 65–100 kw.-hr. per ton.
Steam: 0.5–2 tons (1100–4400 lb.).
Water: 150–250 cu. m. (40,000–65,000 gal.).
Labor: 0.5–1.00 man-hours (basis 100-ton mill).
Investment: $13,000 per daily ton (basis 100-ton mill).
Minimum plant capacity: approximately 100 tons per day.
Total investment: $68,000–$78,000 per daily ton (100-ton mill).
Market price October, 1952: unbleached kraft $100–$125 per short ton; bleached kraft $140–$150 per short ton.

Pollution:

Fiber loss in mill effluent: 2–3% of production.
Five-day B.O.D. of effluent: about 30 kg. (65 lb.) per daily ton.
Minimum stream flow required to maintain dissolved oxygen above 3 p.p.m. (for plant with 100 ton daily capacity):
At 15°C.—6 cu. m. (200 cu. ft.) per sec.
At 20°C.—7 cu. m. (250 cu. ft.) per sec.
At 25°C.—11 cu. m. (400 cu. ft.) per sec.

Recommendation. The sulphate process can be recommended for consideration in the production of both unbleached and bleached paper pulps, particularly where different species must be handled simultaneously.

Soda

Soda pulps are always bleached. They are used mostly for

[12] Detailed estimates regarding operating costs are given in Chapter V.
[13] Under good conditions a pulp mill operating at approximately 50% yield should be capable of generating from the recovery system a small surplus of steam. However, in the initial operation of a new mill additional steam will be required.

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Recent Mill Developments With Cyanamid Paper Chemicals...

Beater time was reduced 40% by a New England mill when it went from a urea resin to PAREZ® Resin 607 (MELOSTRENGTH® Resin) in wet-strength paper. The reduction in beater time means lower power cost, increased dimensional stability of the paper, and reduced curling tendency in the sheet.

* * *

Foam used to be a problem in the de-inking plant of a West Coast mill. That was before a switch was made to ACCOCEL® 741 Pitch Dispersant. After many runs with ACCOCEL, the mill can report "no indication of foaming with this pitch dispersant."

* * *

Another mill has cut size requirements with CYFOR® Fortified Dry Rosin Size Light. Evaluation was made on 21 lb. bond, with 40% Kraft, 60% sulfite furnish. Previously 3¾ to 4% non-fortified size had been needed to meet the dry indicator specification of 20 to 25 seconds. With CYFOR, sizing ran better than 20 seconds at 2½% addition.

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printing papers. They are softer and have lower strength and give lower yields than sulphate pulps from the same species. The sulphate process would ordinarily be chosen because such pulps are better suited for other uses as well and many soda mills are now being converted to sulphate mills. The soda process, however, might be considered where sulphate odors would be objectionable. Most wood species may be pulped satisfactorily, although broadleaved woods are chiefly used. The process does not appear suitable for mixed woods.

Apart from adjustments in the chemical requirements and lower yields (about 10% lower than sulphate) the operating factors are generally similar to those for the sulphate process.

Sulphite

Sulphite pulps are prepared by digesting wood chips in an acid liquor containing calcium bisulphite and sulphurous acid. They are produced in a wide variety of qualities ranging from relatively strong pulps to soft pulps and dissolving grades.

Although the strength of sulphite pulps is normally less than that of sulphate pulps made from the same species, its strength is ample for a very wide range of papers. The relatively light color of the unbleached pulp and the ease of bleaching in three stages to high brightness, recommended its use in many instances.

Except under unusual circumstances it is not used for resinous wood. Experimental work is under way in many countries to increase the flexibility with regard to wood, and to increase strength properties.

Uses. Used with mechanical pulp in newsprint (15 to 20%) and magazine paper (20 to 50%); second class wrapping and bag paper; greaseproof, glassine, and waxing tissue; and all kinds of book and printing paper, bond, blotting, and folding boxboards.

The sulphite process is the most suitable for most dissolving pulps. The majority of viscose pulps and all of the acetate grade pulps are made by the sulphite process.

Species Suitable. Spruce, true firs, and hemlock are preferred. Woods containing phenolic substances such as certain heartwood resins and tannins are not suitable. Included in this latter category are most pines, Douglas-fir, and red cedar for which the sulphate process is preferable. Some pines, however, such as lodgepole and araucaria and young southern pine, with little or no heartwood, can be pulped by the sulphite process. Many broadleaved wood species including poplar, birch, and beech can be used, but some are unsatisfactory for the reasons already stated. The cooking time varies greatly for different wood species and it is therefore difficult, and in some cases impossible, to digest mixtures by this process. Using sodium, magnesium, or ammonium instead of calcium as the base gives better results with the more resistant species.

By-products. Some of the sugars (hexoses) of the spent sulphite liquor can be fermented to alcohol. This is the practice in most Scandinavian and many German mills, in two mills in Canada, and in one mill in the United States. The economy of this process is, however, entirely dependent on the local fuel and alcohol price. The production of alcohol is, furthermore, economically feasible only in the case of coniferous woods, which are rich in mannan. Fermentation can also be conducted in such a way that yeast is obtained. In this case the pentoses are fermented as well. Yeast is produced by this means in Germany, in one mill in Canada and in one mill in the United States. Due to the high xylose content in the spent liquor from cooking broadleaved woods, this kind of sulphite liquor has been considered to be a potential raw material for the production of furfural. This problem, however, has not yet been technically and economically solved. Vanillin is produced in some mills, but only the liquor from coniferous woods is suitable.

Burning of Spent Liquor. Without recovery of the spent liquor, the pollution effect is much greater for the sulphite process than for other pulping processes. Much effort has therefore been devoted, especially in the last 10 years, to the technical solution of the problem of evaporating and burning the calcium-base waste liquor. The problem is now definitely solved and two different processes are in operation with good results in many mills in Sweden. Soluble bases are more adaptable to evaporation and burning of the spent liquor, as well as chemical recovery. Magnesia is used successfully in one mill in the United States with simultaneous recovery of fuel value and chemicals. Sodium bisulphite is used in one mill in Sweden also with recovery of heat and chemicals. Ammonia is used in three mills in the United States and in one in Norway. Extensive trials are being conducted in several other mills. Mill experience with the use of magnesium and ammonium base liquors is described in several publications. Mills producing unbleached wet pulp, and using recovery by burning, can be made entirely self-supporting as regards heat.

Operating data[14] (per metric ton air-dry pulp):

Yield from wood: 40–50%; varies with species and pulp quality.
Limestone: 150 kg. (330 lb.).
Sulphur: 90–150 kg. (200–330 lb.).
Power: 175–300 kw.-hr.
Steam: 1.6–3.4 tons (3500–7500 lb.).
Labor: 2.5–5.0 man-hours (basis 100 tons).
Water: minimum 150 cu. m. (40,000 gal.); average 230 cu. m. (60,000 gal.).
Investment: approximately $45,000–$53,000 per daily ton.
Minimum plant capacity: approximately 100 tons per day.

"Additions" for bleaching:

Chlorine: 30–80 kg. (65–175 lb.).
Sodium hydroxide: 5–15 kg. (10–35 lb.).
Lime: 25–50 kg. (55–110 lb.).
Power: 45–75 kw.-hr.
Steam: 0.4–0.6 ton (900–1300 lb.).
Water: 130–170 cu. m. (35,000–45,000 gal.).
Labor: 0.5–0.75 man-hour (basis 100 tons).
Investment: $9000 per daily ton (basis 100 tons).
Minimum plant capacity: approximately 50 tons per day.
Market price October, 1952: unbleached $125–$140, bleached $140–$150.

Pollution:

Fiber loss in mill effluent: about 2% of product.
Five-day B.O.D. of effluent (without liquor recovery): 190 kg. (420 lb.) per daily ton.
Minimum stream flow required to maintain dissolved oxygen above 3 p.p.m. with oxygen saturation upstream for a mill capacity of 100 tons per day, and without liquor recovery.
At 15°C.—34 cu. m. (1200 cu. ft.) per sec.
At 20°C.—51 cu. m. (1800 cu. ft.) per sec.
At 25°C.—74 cu. m. (2600 cu. ft.) per sec.

Recommendations. The sulphite process is recommended for consideration only for the most suitable species and when a homogeneous raw material is available. This process is particularly suitable for the production of purified pulps for chemical conversion.

During the last 10 years only two new sulphite mills—one of which produced rayon pulp—have been built in the world, although many new sulphate mills have been constructed. One sulphite mill on magnesium base is being built in Alaska for the manufacture of dissolving pulps.

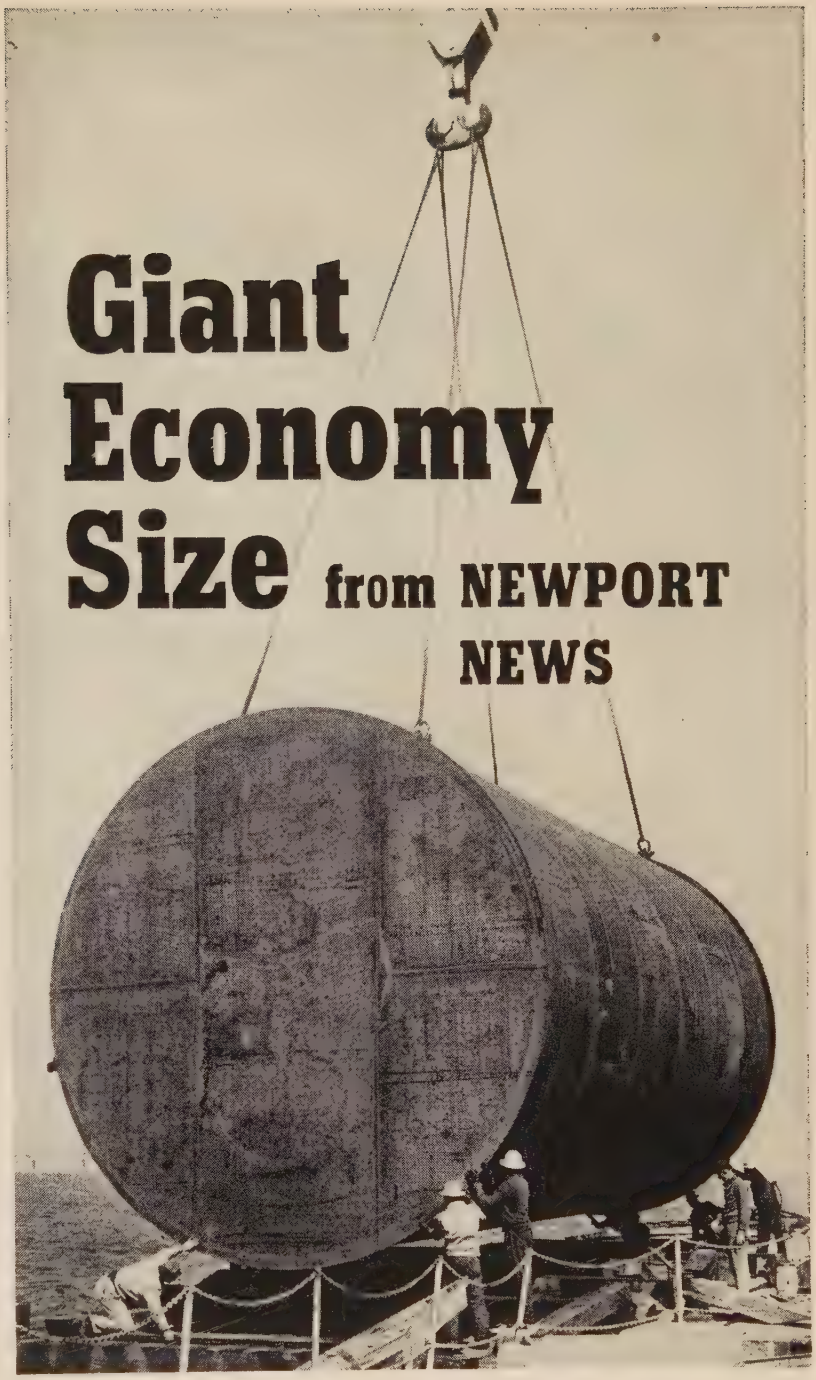
Other Pulping Processes

Many chemicals in addition to those now used for pulping may be employed to delignify wood and other fibrous raw materials. Among those mentioned in current literature are higher alcohols, glycols, phenol, hydrotropic chemicals, and nitric acid. Various proposals have been made for the use of these chemicals as pulping agents, often with interesting claims for the possibility of making valuable by-products.

[14] Detailed estimates regarding operating costs are given in Chapter V.

Why a Southern paper mill ordered the...

Giant Economy Size from NEWPORT NEWS



Papermakers usually encounter some perplexing problems when pressure vessels, digesters, tanks or similar large size units are involved.

For instance, a southern paper mill required ten lime storage tanks like the one pictured here. The size, 20 feet in diameter by 40 feet in length, obviously prohibited one-piece delivery by rail.

However, the mill found a way to eliminate field assembly problems and avoid needless labor costs, as well as to save valuable erection time . . . by handing the job to Newport News.

Specialists in metal fabrication, Newport News produced these tanks in the shop, then loaded them on barges for direct shipment, fully assembled, ready for immediate installation upon arrival.

This illustrates how deep water shipping, along with sixty-seven years' experience in building just about any kind of vessel you could name, has enabled Newport News to provide money-saving answers for scores of papermakers.

Papermaking equipment built by Newport News has set outstanding performance records in leading mills at home and abroad. So whether you use *rolls or log barkers . . . head boxes or pressure vessels . . . digesters, tanks or special equipment . . .* let us bid on your needs. Learn how Newport News can help you . . . our illustrated booklet *"Facilities and Products"* is yours for the asking. Write for your copy today.

Nine more to go. You're looking at one of ten lime storage tanks being loaded on a barge for direct shipment from Newport News' plant. Complete assembly of these units in the shop not only saves labor and money but expedites installation upon arrival at the paper mill.

Newport News

Shipbuilding and Dry Dock Company

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Up to the present time, however, none has shown any promise of producing better pulp, and the cost would be much greater than that for conventional processes. Such processes should not be considered for new mills. It is doubtful if any have been developed sufficiently for even pilot-plant demonstration.

Processes are available for pulping practically all cellulosic fibrous materials. There is seldom any necessity to consider new or untried processes for new mills using new materials. Improvement of processes and development of processes to give higher yield, better pulps, by-products, and better efficiency should be encouraged, but this should be considered as an entirely separate problem. Starting an industry using a new process for new materials merely involves tackling two problems when only one is necessary.

III. PULPING PROCESSES FOR NONWOOD MATERIALS

Extensive research and industrial experience have shown that alkaline pulping methods are preferable in the case of cereal straws, esparto, sabai and other grasses, as well as sugarcane bagasse, corn or sorghum stalks, reeds, bast, and hard fibers. The same practice also holds good in the case of bamboo and residues possessing woody stalks such as cotton, soya bean, hemp, seed flax, or crotalaria. Investigations and new industrial practices in pulping these residues, since World War II, have led to improvements in yield and pulp quality as well as cleanliness (particularly in the case of bleached pulps). This in turn has directed more fundamental research into the papermaking possibilities of these abundant, and in many cases wasted, raw materials. It is expected that the next few years may well see the development of even better procedures and wider usage. Pulps made from them, when blended with other pulps from both coniferous and broadleaved woods, can certainly lead to improved paper products.

The following processes, which are described in detail later in this chapter, are in successful commercial operation although yields and qualities of pulps, as well as operating costs, will obviously vary according to the specific raw material used and the process selected:

Lime process: Suitable only with cereal straws, grasses, bagasse, or similar stalks in the manufacture of unbleached pulps for board or coarse wrappings.

Conventional soda process (under pressure): Suitable for pulping any of the residues mentioned (including woody stalks) to produce coarse, medium, or fine paper pulps.

Conventional sulphate process (under pressure): Suitable for use with any of the residues mentioned, but more suitable for pulping residues having woody stems. This process is used as a two-stage method in the pulping of bamboo. A modification e.g., soda plus elemental sulphur, as also employed for pulping seed flax tow and sugarcane bagasse.

Neutral sodium sulphite: This process, which uses from 4 to 12% sodium sulphite, together with either soda ash or caustic soda as a buffering agent, is suitable for pulping almost all of the agricultural residues. It gives lighter unbleached pulps than those obtained by the soda or sulphate processes, and the pulps bleach well.

Caustic soda–chlorine process: Suitable for pulping cereal straws, esparto and other grasses, as well as sugarcane bagasse. In addition, it could be used for corn, sorghum, or similar stalks, but it is not suitable for bamboo or residues with woody stems. A one-stage soda process under very low pressure is used for preparing coarse pulps and a two-stage process, using caustic soda and chlorine, to make fine paper pulps of easy bleachability.

Mechano-chemical process: This process is suitable for the pulping of cereal straws, esparto and other grasses, corn, sorghum or reeds, and similar stalks. It is not suitable for wood, bamboo, or residues with woody stems. Either soda, sulphate, or lime pulping liquors are employed and only very short periods of time and atmospheric pressure are needed. Neutral sodium sulphite cannot be used. By regulating the amount of chemicals and time, board or bleached pulps may be produced from all of the raw materials for which the process is suited.

Procurement and Storage of Agricultural Residues

The procurement and storage of nonwood materials is most important. It has a direct bearing, not only on the economics of utilizing these materials as a source of cellulose, but also on pulp yields and quality. Very little has been done to improve mechanical means for procuring such residues, which are separated in many cases at the time of harvest of the grain or seed.

Straw

In the case of cereal straws, generally the grain must be harvested when dry. At this time the straw has reached maturity and used up its readily soluble reserve of carbohydrates and proteins. It should be collected when driest, baled, piled, and protected from decay. Green weeds among the straw will cause rotting in the bales or piles. Methods for storing straw for more than a year, with practically no loss, have been perfected in the United States.

Sugarcane Bagasse

This residue contains about 50% moisture, from 2 to 4% sugar, and to be economically handled, should be baled as it comes from the sugar mill. A method developed in the United States, and which has been in practice for about 25 years, results in no more than a 10% loss of fiber even after storage for 1 to 2 years. Before this method was discovered the fiber loss was in the neighborhood of 30%.

Esparto Grass and Sabai Grass

These materials are gathered in dry condition and if properly stored will suffer little loss or fiber decay. In considering the use of other grasses the same considerations apply.

Seed Flax

Tow is prepared from flax straw by treating the whole in a mill to loosen the bast fiber from the woody portion. Many small woody pieces, called "shives," cling to the tow, of which the yield is only about 20% of the total straw. The material is baled in dry condition and stored entirely under cover.

Corn Stalks

Corn, sorghum, and other similar stalks, which ripen only in the late Autumn, are ordinarily collected in a condition of high moisture content, and are difficult to store without deterioration. Moreover, in the United States, and to some extent elsewhere, the use of mechanical harvesters makes economical collection of stalks very problematic. In Turkey a variety of corn stalk is used for the manufacture of paper, but only in a small way. This particular variety matures in the summer when the stalk may be harvested by hand in dry condition.

Bamboo

Generally bamboo of about 3 to 4 years' growth is felled. The green bamboo varies in moisture content from the bottom of the stem to the top, but on air drying for about 2 to 3 months, the whole stem attains a uniform moisture content. After felling, the material is transported to the pulp and paper mill, and stacked in the open. A 6 to 9 months' stock is usually considered sufficient.

Hard Fibers

These often command a higher price in the textile, rope, brush, or other market, than as a raw material for pulp manu-

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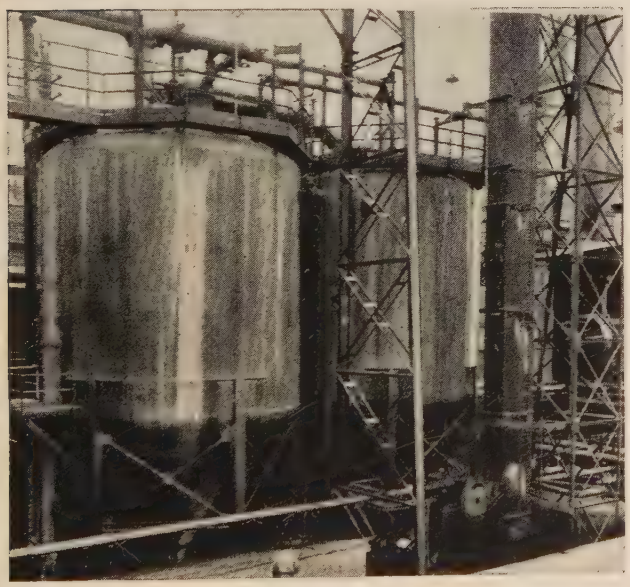

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used—thus changing the mild causticity of the straight lime cook to one much stronger—so the yield is lowered, and with caustic soda alone yields are in the neighborhood of 65%.

In the United States it is customary to add various percentages of waste corrugating material, partly because of price considerations, but mainly to obtain a freer pulp in order that faster running conditions may be achieved on the paper machine. In Europe the practice of cooking with lime is confined to straw alone. The pulp is subjected to very little washing and yields may be as high as 80%.

When considering yields, account of course must be taken of the effect that different types of straw—due to variety and location—have on the over-all yield of pulp.

Uses. For the manufacture of corrugating board, solid fiberboard, and coarse wrapping and packing papers.

Species Suitable. All kinds of cereal straw (especially wheat and rye), corn stalks, and sugarcane bagasse. The process is suitable for operation on a small scale and a wide variety of plants from the grass family could be pulped in this manner. Differences in quality of the pulp produced, however, are naturally to be expected with each particular raw material used.

Bleaching. The lime process does not produce a bleachable pulp.

Operating data[15] (per metric ton air-dry pulp):

Yield from straw: 65–80%.
Lime: 100–150 kg. (220–330 lb.).
Power: 70–150 kw.-hr. dependent upon the extent of defibering and screening of the pulp for the paper machine.
Steam: 0.9 ton (2000 lb.).
Water: down to 25 cu. m. (6500 gal.) per ton minimum.
Labor: 4–8 man-hours.
Minimum plant capacity: about 5 tons per day.

Pollution. The pollution problem is serious and chemical recovery is not possible.

Soda

The first application of the soda process was in the pulping of esparto grass, and its use for this purpose still continues today. Esparto—mainly because of its unique fiber characteristic—represents one of the finest raw materials for the manufacture of high-grade book and other printing and coating base papers. From the outset, the general endeavor in pulping this raw material has been to produce a rather soft pulp and consequently the pentosan content had to be lowered by the cooking process. This resulted in the use of rather high amounts of caustic soda, which nonetheless seemed to fit in better with the recovery process necessary in many instances, not only from the standpoint of economy, but also to minimize stream pollution.

The tendency, therefore, in applying this process to the pulping of straw and bagasse, has been to follow the pattern set by esparto. Because of the shortage of esparto during World War II, U. K. mills in particular were obliged to pulp straw in their esparto equipment and to use essentially the same conditions for straw as those they employed for esparto. Perhaps lack of screening equipment was a contributory factor, for the nodes of the straw had to be well pulped. This, in turn, led to the production of very wet pulps, since the cooking of high pentosan-content annual plants causes a very distinct swelling of the fibers. The result of this "chemical hydration" was to give pulps which ran slowly on the machine and produced paper defects. Looking back over older practice in straw pulping, and particularly in Europe, it may be seen that perhaps some of the difficulties in washing pulps and their wet behavior on the machine, may also be attributed to the use of too high an amount of chemicals and conditions being too severe. It seems important to bring this fact out, for it has since been found that satisfactory pulps can be made by other processes—less drastic than most—requiring a considerably smaller amount of caustic soda.

Because of differences in viewpoint, conditions for pulping straw and bagasse have varied in mills, both in regard to the amount of chemical used, as well as time (2 to 6 hr.) and temperature conditions (130 to 170°C.).

Uses. Two types of pulp are prepared by the soda process. One type containing considerable lignin is used to manufacture corrugating and solid fiber board, and wrappings. The other (fine bleached pulp), may be used for a wide variety of printing and writing papers, greaseproof and glassine, and for high grade boards such as Bristol.

Species Suitable. For board pulp: cereal straws, with the exception of oat and barley (and certain others which contain a high proportion of leaf), corn stalks, sugarcane bagasse, and such materials as cotton stalks, soya bean stalks, and crotalaria.

For bleached pulp: cereal straws (excluding oat and barley) sugarcane bagasse (especially when a considerable portion of pith has been removed), and grasses.

Bleaching. Pulps manufactured by the soda process can be bleached to a brightness of 65 to 70 in one stage with bleaching powder (using 4 to 6% available chlorine) and to a brightness of 80 with a modern three or four-stage process for which up to 6 or 10% chlorine may be required.

Operating data[16,17] (per metric ton air-dry pulp):

	Board pulp	*Bleached pulp (brightness about 80)*
Straws	60–65% yield	40% yield
Grasses: sabai	65–70% yield	35–36% yield
esparto		35–45% yield
Whole bagasse	55–60% yield	36–40% yield
Depithed bagasse	65–70% yield	46–50% yield
Woody stalks	65% yield approximately	
Caustic soda	60–130 kg. (130–285 lb.)	220–400 kg. (485–880 lb.)
Chlorine	.....	60–100 kg. (130–220 lb.)
Power	200 kw.-hr.	350–450 kw.-hr.
Steam	1.2 tons (2700 lb.)	3 tons (6600 lb.)
Water	75–95 m.³ (20,000 to 25,000 gal.)	150–200 m.³ (40,000–55,000 gal.)
Labor	4–8 man-hours	5–9 man-hours
Minimum plant capacity	10 tons per day	20 tons per day

Pollution. The stream pollution problem is serious. Recovery systems have been installed in some esparto mills, but most straw mills have no recovery system at all.

Cold Caustic Soda[18]

This process is used only for the manufacture of glassine pulp from straw. As used in one Italian mill, it consists essentially of soaking the straw in a 4 to 5% solution of caustic soda in a pit for 15 days. The pulp obtained is very wet and may be beaten to make glassine with ease.

Uses. One hundred per cent to manufacture glassine papers, or alternatively, in a blend with 10% spruce sulphite pulp (bleached to low brightness).

Species Suitable. Only wheat straw. Might possibly be applied to bagasse and some grasses.

Operating data (per metric ton air-dry pulp):

Yield from straw: 45%.
Caustic soda: 230–250 kg. (510–550 lb.).
Chlorine: 60–90 kg. (130–200 lb.).
Power (approximate estimation): 1000 kw.-hr. (including paper machine conversion of pulp).
Steam: no process steam required.
Labor: 20–24 man-hours.

[15] Detailed estimates regarding operating costs are given in Chapter V.

[16] The details given are for minimum capacity plant without alkali recovery. Inclusion of an alkali recovery system will usually prove economic in mills of more than 25 tons daily capacity, and operating data will be greatly altered in consequence, closely approaching that for sulphate operations.

[17] Detailed estimates regarding operating costs are given in Chapter V.

[18] The process is especially suitable for small mills.

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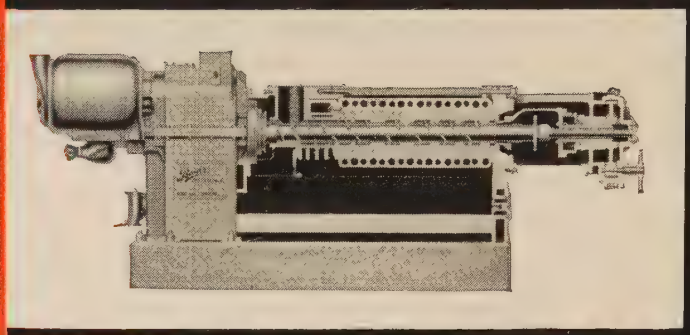

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Sulphate

The sulphate process has been used to a limited extent for pulping cereal straws, and so far as comparison with the soda process is concerned gives a somewhat higher yield and a stronger pulp. From an alkalinity point of view the amounts of sulphate chemicals employed are, in general, equivalent to those used in the soda process. Similarly, operating estimates for the soda process apply in much the same way for sulphate.

One mill in Holland is successfully using the sulphate process to produce high-grade bleached straw pulps. The modified sulphate process—which consists of adding elemental sulphur to the soda cooking liquor—has found usage in the pulping of seed flax tow for the production of cigarette and other fine papers, particularly in Canada and the United States. A similar modification is also being used at the present time for the pulping sugarcane bagasse for the production of a wide range of board and other papers.

Uses (as for soda pulps).

Species Suitable (as for soda pulps).

Bleaching (as for soda pulps).

Operating data[19,20] (per metric ton air-dry pulp):

	Board pulp	*Bleached pulp (brightness about 80)*
Straw	60–65% yield	About 40% yield
Grass: sabai	65–70% yield	35–36% yield
Whole bagasse	55–60% yield	36–40% yield
Depithed bagasse	65–70% yield	47–48% yield
Woody stalks	65% yield approximately	.....
Caustic soda	45–90 kg. (100–200 lb.)	150–200 kg. (330–440 lb.)
Sodium sulphide	20–45 kg. (45–100 lb.)	70–130 kg. (155–285 lb.)
Chlorine	.....	60–100 kg. (130–220 lb.)
Power	200–400 kw.-hr.	350–500 kw.-hr.
Steam	1.2 tons (2700 lb.)	3 tons (6600 lb.)
Labor	4–8 man-hours	5–9 man-hours
Minimum plant capacity	10 tons per day	20 tons per day

The Pulping of Bamboo. In India bamboo is pulped by the sulphate process. Because its anatomical structure, however, makes penetration with cooking liquor difficult, the material is first crushed and the pieces then graded by screening. The conventional method of pulping is preferred to preparing the unbleached grade but, in the case of bleached pulp, digestion is carried out in two stages ("fractional method").

In making unbleached pulp for high-class wrapping papers the bamboo is digested with about 16 to 17% of chemicals (liquor:bamboo ratio 4:1) at 142 to 153°C. for 5 to 6 hr., the resultant yield being approximately 50%. For making bleachable pulp, the refortified spent liquor (11% alkali as NaOH on the basis of moisture-free raw material) from the second stage of digestion is used in the first stage. Pulping is carried out at about 115 to 121°C. for 2 hr. In the second stage, 20% of chemicals are used, and it is desirable to raise the temperature to 162°C. for the first 30 min. and to carry out the last 2.5 hr. of cooking at 148°C. Yield before bleaching is some 43%.

The pulp, at about 5 to 7% consistency, is bleached with calcium hypochlorite in one stage to 80 brightness, the final yield being of the order of 40%.

The Pulping of Bast Fibers. In North America several hundred thousand tons of seed flax straw are used annually for the manufacture of cigarette and other fine papers. After threshing or combine harvesting to obtain the flax seed, the straw is processed in a tow mill to separate as much as possible of the woody elements (shives) from the bast fibers. From 100 tons of flax straw, some 30 tons of "tow" (i.e., the bast fibers with some of the shives still attached) are obtained. This is baled and stored under cover, the rejected shives being burned or finding some use in insulating board manufacture.

The tow fiber is digested with about 20 to 22% caustic soda plus 3% sulphur for 5 to 6 hr. at 150 to 160°C., and the resultant pulp washed and "cut" in a beater. It is then bleached (also in a beater) to a brightness of 70 to 75 using 6 to 10% chlorine, or to 80 brightness in the conventional three-stage system with up to 10% chlorine. The yield of pulp based on the material added to the digester is approximately 43%, but on the basis of original straw is only about 13%. Some 70% of the bleached pulp fibers are derived from the bast fibers, the remaining 30% coming from the woody stem.

Uses: For the manufacture of cigarette paper, currency, and other fine printing papers, etc.

Species suitable: Tow from seed flax straw, hemp, and ramie.

Operating data: Because of the low yield of papermaking fiber from flax straw, costs are very high and the pulps should be only considered for expensive specialty paper.

Neutral Sulphite or Monosulphite

About 15 years ago the neutral sulphite process was introduced for the production of fine bleached pulps from straw. Sodium sulphite is the principal chemical used but the liquor at the end of the cook must be maintained slightly on the alkaline side in order to prepare high quality pulps. For this purpose, either sodium hydroxide or sodium carbonate has been used. In the case of sodium hydroxide the tendency is to produce a pulp of slightly lower yield, possessing more the character of soda pulp. With sodium carbonate a rather higher yield is obtained.

Within the last 4 or 5 years in the United States the neutral sulphite process—with some modifications and using substantially lower amounts of chemical—has been applied to the production of corrugating medium from straw. It has been found that a more rigid board may be made comparing favorably in crush resistance to boards from semichemical broadleaved wood pulps.

The process differs from those more alkaline, in that the hemicelluloses are not so readily attacked and removed, thus giving rather higher yields. By varying the amount of chemicals, cooking time, and temperature, both semichemical and more delignified pulps may be obtained.

Uses. The coarse pulps are suitable for corrugating board, solid fiberboard, folding box board, and liner board, the latter best being made by blending the straw pulp with coniferous wood pulps. The bleached grade may be used 100% for the manufacture of greaseproof and glassine, but is generally blended with other pulps for the manufacture of all kinds of fine writing and printing papers.

Species Suitable. Especially suitable are the various cereal straws (excluding oat and barley), bagasse (particularly when a considerable amount of pith has been removed), and grasses.

There is an indication that woody stalks, such as cotton, soya bean, hemp, and seed flax could also be pulped by the neutral sulphite process. The conditions required for these materials are very similar to those needed for the pulping of broadleaved woods, though the fiber length of the woody portion tends to be shorter. The general characteristics of pulps from such woody stalks are not usually as favorable as those from straw or bagasse.

Bleaching. The more delignified pulp may be readily bleached to a moderate degree of brightness in one hypochlorite stage. A three-stage bleach employing chlorination, alkali extraction, and final hypochlorite brightness bleaching is preferable, however, for it gives higher brightness and better strength.

Operating data[21, 22] (per metric ton air-dry pulp):

[19] The details given are for minimum capacity plant without alkali recovery. Inclusion of an alkali recovery system will usually prove economic in mills of more than 25 tons daily capacity, and operating data will be greatly altered in consequence.

[20] Detailed estimates regarding operating costs are given in Chapter V.

[21] Detailed estimates regarding operating costs are given in Chapter V.

[22] Some plants use electrolytic cell liquor for making up the cooking solution and the presence of salt during digestion may influence pulp properties and decrease bleachability.

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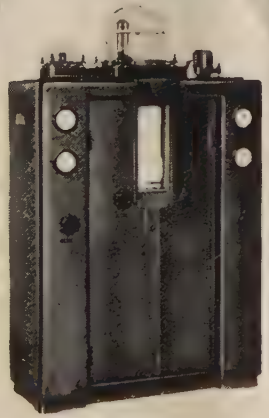

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	Board pulp	*Bleached pulps*
Straw	55–65% yield	42–50% yield
Bagasse (pith removed)	.....	50% yield
Sodium sulphite	55–130 kg. (120–290 lb.)	140–220 kg. (310–490 lb.)
Sodium carbonate	30–40 kg. (65–90 lb.)	40–90 kg. (90–200 lb.)
Chlorine	.....	50–100 kg. (110–220 lb.)
Power	200 kw.-hr.	350–450 kw.-hr.
Steam	1.5 tons	3.1 tons
Water	75–95 m.[3] (20,000–25,000 gal.)	150–380 m.[3] (40,000–100,000 gal.)
Labor	4–8 man-hours	5–9 man-hours
Minimum plant capacity	20 tons per day	20 tons per day

Pollution. This problem still remains to be solved.

Recovery. None unless integrated with a sulphate mill.

Caustic Soda-Chlorine

This process, which is continuous, uses no pressure vessels, but open towers with buffer tanks in between. Primary delignification is achieved by treatment with a weak caustic soda solution in a steam-heated tower, and the digested raw material thus obtained is used for the manufacture of corrugating medium, boards, and some types of wrapping papers. Such semipulps may be bleached to a creamy white color in a single stage with hypochlorite, and are then suitable for addition to newsprint, envelope, and other furnishes.

In making semipulps from straw, the material is soaked in a 2% solution of caustic soda and digested in the tower at a liquor straw ratio of about 3:1 for approximately 1 to 1.5 hr.

In the case of fine bleached pulp, the straw is soaked in a 3% caustic solution and the digested material washed, pressed to a consistency of about 30% followed by fluffing in an opening machine, and eventually passed through a tower (about 20 to 30 min.) into which chlorine gas is injected. After chlorination the pulp is submitted to caustic extraction, screened, and finally bleached in one or two stages with hypochlorite.

Whereas the earlier mills employing this process—particularly those in countries having no chemical industry—used the complete output of an electrolytic plant, some now purchase their individual requirements of chlorine and caustic soda.

Uses. The semipulp may be made into all types of boards and ordinary wrapping papers where tear resistance is not of great importance. When mixed with coniferous groundwood pulp, it is suitable for newsprint furnishes, envelope papers, and cheap writing and printing papers.

The bleached pulps are used for the manufacture of writing, printing and glassine papers, but usually in blends with long fiber pulps to make a variety of qualities.

Species Suitable. Cereal straws, sugarcane bagasse, esparto, and perhaps other grasses.

Bleaching. While bleached semipulps may range in brightness from 65 to 75, the full process will yield pulps with a brightness of over 80.

Operating data[23] (per metric ton air-dry pulp):

(a) *Semipulp:*	*Cereal straw (uncleaned)*	*Sugarcane bagasse (not depithed)*
Yield	60–65%	65–70%
Caustic soda	140–160 kg. (310–350 lb.)	130–150 kg. (290–330 lb.)
Steam	1.1–1.5 tons (2400–3300 lb.)	1.1–1.5 tons (2400–3300 lb.)
Power	150–170 kw.-hr.	140–160 kw.-hr.
Water	50 m.[3] (13,000 gal.)	50 m.[3] (13,000 gal.)
Labor	2–4 man-hours	2–4 man-hours
Minimum plant capacity	10 tons per day	10 tons per day

(b) *Bleached pulp* (about 80 brightness):[24]

	Cereal straw (uncleaned)	*Sugarcane bagasse (depithed by dry method)*
Yield	40–45%	45–48%
Caustic soda for digestion	200–250 kg. (440–550 lb.)	170–225 kg. (370–500 lb.)
Chlorine for gas chlorination	190–220 kg. (420–490 lb.)	130–150 kg. (290–330 lb.)
Caustic soda for alkaline wash	30 kg. (65 lb.)	30 kg. (65 lb.)
Available chlorine (in hypochlorite) for bleaching	15 kg. (35 lb.)	15 kg. (35 lb.)
Steam[25]	2.1 tons (4600 lb.)	2.1 tons (4600 lb.)
Power	400–450 kw.-hr.	350–400 kw.-hr.
Water	300–500 m.[3] (80,000–130,000 gal.)	300–500 m.[3] (80,000–130,000 gal.)
Labor	4–6 man-hours (excluding electrolysis)	4–6 man-hours (excluding electrolysis)
Minimum plant capacity	20 tons per day	20 tons per day

Pollution. Presents a very difficult problem.

	Cereal straw		*Bagasse*	
	Salt	*Kw-hr.*	*Salt*	*Kw.-hr.*
Diaphragm cells	450–500 kg. (1000–1100 lb.)	650–800	360–450 kg. (800–1000 lb.)	500–600
Mercury cells	400–450 kg. (900–1000 lb.)	850–950	300–350 kg. (650–750 lb.)	700–750

The salt figure for diaphragm cells includes recovery from the cathodic liquor.

Recovery. Recovery of chemicals is not possible.

Mechano-chemical

This process consists of pulping cereal straws, bagasse, etc. in a hydrapulper, or similar machine, at atmospheric pressure at a temperature of 980°C. for 30 to 90 min. depending on the raw material and type of pulp desired. Certain straws do not require prior chopping or cleaning. The hydrapulper must be supplied with an oversize rotor and with a more powerful motor than is normally employed for pulping waste papers. The extraction plate should also be replaced with a solid plate, and a large discharge line with quick release valve fitted to allow rapid expulsion of the pulp. Consistency at the beginning of operations should be as high as possible, at least 10 to 12%, and at the end may range from 6 to 8%.

For the manufacture of corrugating board, lime and soda ash (or caustic soda), or caustic soda alone may be used. With lime about 10% of lime on the moisture-free weight of straw is required. With mixtures, 6% lime and 1.5% caustic soda; with caustic soda alone, 5 to 6% are needed for pulping straw, and about 8% for bagasse. Duration of pulping is from 60 to 90 min. Using caustic soda, large-scale paper mill runs have shown that high-grade corrugating medium may be made.

Before washing, the hot pulps are defibered in disk or other refiners and if large amounts of weeds are present, these can be separated before defibering by passing the pulps through coarse screens.

For the manufacture of liner grade, the amount of caustic soda is increased to approximately 8% in the case of straw and 10 to 12% for bagasse. Such pulps may also be defibered before washing, but should be screened before final refining for the paper machine.

For production of bleached pulp the straw should be chopped to a length of about 5 to 7.5 cm. (2 to 3 in.) and then dusted over a 20-mesh screen. Either soda or sulphate chemicals may be used. For straw about 12 to 13% chemical (NaOH or NaOH + Na_2S) on moisture-free material is needed with a cooking time of from 30 to 35 min. The pulp from the hydrapulper is first washed over a vacuum filter, then after passing through a coarse screen the uncooked nodes, heads, etc.—which do not break down during the process—are

[23] Detailed estimates regarding operating costs are given in Chapter V.

[24] The chemicals are generally supplied by an electrolytic plant on site, the following requirements being necessary to produce chemicals sufficient for 1 ton of pulp:

[25] For digestion. None is usually required for bleaching.

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removed by riffling and sorting through flat screens with 0.2 mm. (0.008 in.) slots, or rotary screens with 0.3 mm. (0.012 in.) holes. The screenings and rifflings may be further defibered by treatment with water in a small hydrapulper or similar equipment, followed by centrifugal separation. The fibers are then screened again and the rejects discarded or used in board manufacture.

With bagasse 12 to 16% chemical and a cooking time of 45 to 80 min. are required. The hot pulp from the hydrapulper may be defibered and screened, the screenings being returned to the next cook.

Bleached mechano-chemical pulps are distinguished from more conventional wheat straw or bagasse pulps by being low in ash (about 1.0 to 1.5%), high in pentosan (30 to 33%), quite free (20 to 25° S.R.) and easy to refine (30 min. in the TAPPI Standard beater) to a strength approaching that of coniferous wood pulps, except for tear resistance. Pulps made by this process from rice straw have 3.5 to 5.0% ash, and are stronger than those obtained by pressure cooking.

The process is simple to control and very rapid. The high strength of the pulps obtained is attributed to the fact that the mild conditions employed do not degrade the hemicelluloses as much as pressure cooking.

The process, which is now in commercial operation, is particularly well suited for use in small mills because pulpers of almost every size are available. Moreover, these pulpers may also be used to repulp broke or waste papers.

Uses. The unbleached pulps may be used for high-grade corrugating, liner or coarse wrappings; the bleached, for a wide variety of fine papers, their best use being in blends with other pulps.

Species Suitable. Cereal straws, bagasse, and grasses.

Bleaching. The pulp may be bleached to a brightness of 70 with up to 10% chlorine in one stage, and to a brightness of 80 with 10 to 15%, depending on the raw material, In the latter case, bleaching is carried out in a three-stage system.

Operating data[26] (per metric ton air-dry pulp):

	Board pulp	*Bleached pulps (brightness 80)*
Cereal straws	65% yield	48–50% yield
Depithed bagasse	70% yield	48–50% yield
Caustic soda (straw)	85–100 kg. (190–220 lb.)	145–200 kg. (320–440 lb.)
Lime (straw)	140 kg. (310 lb.)	.....
Caustic soda (depithed bagasse)	65–80 kg. (145–180 lb.)	200–220 kg. (440–490 lb.)
Chlorine	.....	90–140 kg. (200–310 lb.)
Power	250–300 kw.-hr.	450–550 kw.-hr.
Steam	2.0–3.0 tons	3.0–4 tons
Water	100–120 m.^{3} (25,000–30,000 gal.)	150–200 m.^{3} (40,000–50,000 gal.)
Labor	5–10 man-hours	6–14 man-hours
Minimum plant capacity	5 tons per day	20 tons per day

Pollution. The same problem as with all processes without recovery.

Recovery. The black liquor may be reused in cooking to conserve heat and chemicals (about 10% of the alkali added remains in black liquor). Up to now, however, no recovery trial has been made on an industrial scale and in any case evaporation costs would be higher than those in the conventional sulphate process due to low concentration of solids in the black liquor.

IV. SUITABILITY OF FIBROUS RAW MATERIALS FOR DIFFERENT PAPER PRODUCTS

General Considerations

Morphological Properties

Fiber dimensions have a considerable effect on the properties of paper.

[26] Detailed estimates regarding operating cost are given in Chapter V.

Fiber length influences tear resistance, in general, longer fibers giving higher tear. However, in discussing the influence of fiber length on tear resistance, it must be pointed out—especially for broadleaved and tropical woods—that it is less the absolute value of the fiber length than the ratio of fiber length to fiber diameter that is of importance. The higher this ratio is, the greater the tear resistance becomes.

Fiber length has practically no influence on such properties as tensile strength and burst, provided the fiber length is above 0.8 mm. Folding strength also seems to be little affected by fiber length. The sheet formation properties are better for short fiber pulps than for long fiber pulps.

The ratio cavity diameter to fiber diameter determines the flexibility of the fiber. Fibers with walls thin in relation to the diameter collapse on drying to form flat flexible ribbons which give a denser sheet than the stiffer thick wall fibers. The denser the paper, the higher, in general, are such strength properties as burst and tensile strength and the lower is the opacity. For coniferous woods, papers obtained from thick wall fibers have higher tear resistance than those obtained from thin wall fibers. For broadleaved woods, however, this statement does not seem to have the same general value.

The flexibility of the fibers also influences the folding resistance of the paper. The more flexible the fiber the higher, generally, is the folding strength. However, the internal structure of the fiber wall interferes at least to the same degree.

Chemical Properties

Among the different chemical characteristics of the fibers, the hemicellulose content is the most important from the papermaking point of view.

It would therefore be of interest to know the hemicellulose content of different raw materials and of different pulps. Unfortunately, such data are not often available. A rough estimation can be obtained by assuming that all but cellulose, lignin, extractives, and ash is hemicellulose. For tropical broadleaved woods and agricultural residues, the hemicellulose content may be the same as the pentosan content. In coniferous wood pulps, however, the hemicellulose fraction largely consists of mannan and xylan.

In general, fibers with high hemicellulose content swell more rapidly on beating than those of low hemicellulose content. The drop in freeness of easily hydrated pulps is usually so rapid that little fibrillation takes place during beating.

The higher the hemicellulose content the denser the sheet, and the higher the burst, tensile, and folding strength factors the lower is the opacity.

Depending on process conditions, the hemicellulose is more or less dissolved during cooking. Hemicellulose is easily hydrolyzed by acids, and therefore sulphite pulps are in general low in hemicellulose content. As a matter of fact, it is possible to obtain pulps with very low hemicellulose content by sulphite cooking (dissolving pulps), but if the acidic conditions are properly controlled, it is also possible to obtain sulphite pulps relatively high in hemicellulose (greaseproof pulps). In general, alkaline cooking conditions have a less drastic action on the hemicellulose. This is particularly so in neutral sulphite cooking, and such semichemical pulps are characterized by very high hemicellulose content.

Coniferous Wood Fibers

They are in general long, the average fiber length of spruce, fir, and pine being between 2 and 3 mm. Some species have still longer fibers, for instance western hemlock, Douglas-fir, and southern pines with an average of 4 to 5 mm. Araucaria pine is characterized by its exceptionally long fibers, ranging up to 7 mm.

Due to long fibers, the tear resistance of papers produced from coniferous wood pulps is high.

Douglas-fir and southern pines have thicker fibers than

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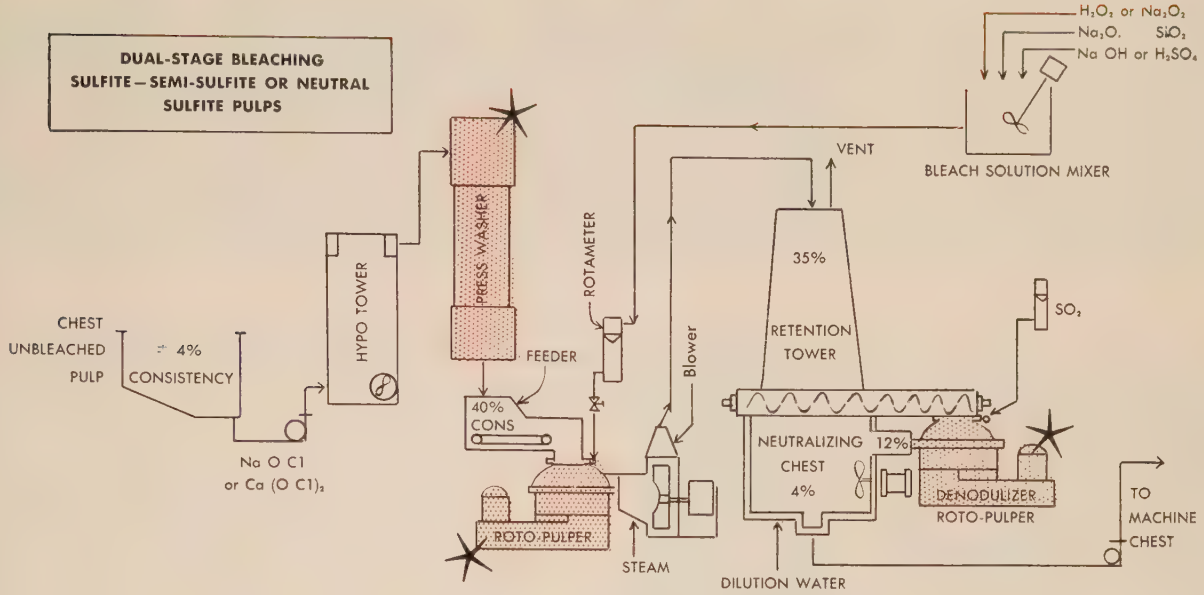

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Table I. Characteristics of Fibrous Raw Materials

Group	Fiber: Average length, mm.	Fiber: Average diameter, micron	Ash, %	Lignin, %	Alpha-cellulose, %	Pentosans,[a] %	Raw-material texture
1. Straws and grasses	1.1–1.5	9–13	6–8	17–19	33–38	27–32	Open
Rice straw	1.5	8.5	14–20	12–14	28–36	23–25	Open
2. Stalks and reeds	1.0–1.8	8–20	3–6	18–22	33–43	28–32	Open
Sugarcane bagasse, depithed	1.7	20	2	19–21	40–43	30–32	Open
3. Woody stalks with bast fibers:							
Woody stems	0.2–0.3	10–11	2–3	23–27	31–33	15–22	Dense
Bast fibers	20.25	16–22	1–2	1–6	60+	2–6	Open
4. Leaf fibers	6–9	16–18	1	7–10	53–64	17–24	Open
5. Bamboos	3–4	14	1–3	22–30	50+	16–21	Dense
For comparison:							
Temperate coniferous woods	2.7–1.6	32–43	1	26–30	40–45	...	Dense
Temperate broadleaved woods	0.7–1.6	20–40	1	18–25	38–49	...	Dense

[a] In nonwood materials the hemicellulose fraction consists chiefly of pentosan, whereas in woods other carbohydrates are also present.

spruce, fir, and pine. The properties of western hemlock fibers lie somewhere in between. Also from this point of view araucaria pine is markedly distinguished from other coniferous woods, the fibers being very thick and stiff.

For some kinds of paper, including the important group of kraft and bag papers, it is desirable to obtain a good combination of burst and tearing strength. Such combined strength properties are obtained, for instance, by using thin wall coniferous wood fibers. Thick wall fibers tend to give higher tear but lower burst. If, on the other hand, coniferous wood pulps—in addition to broadleaved wood or other short-fiber pulp—are simply used as a means for increasing the tear strength, it seems more appropriate to use thick wall fiber pulps. For such mixtures araucaria pulp is of special interest.

Broadleaved Wood Fibers

These are shorter than coniferous wood fibers, and, in general, temperate broadleaved fibers are shorter than those of tropical broadleaved woods. Whereas the bulk of coniferous wood pulps consists of tracheids, broadleaved wood pulps consist of both true fibers and vessels. The length of temperate broadleaved wood fibers varies greatly with the species and ranges between 0.7 and 2 mm., though many species have an average below 1 mm. The vessels are shorter than the fibers.

If properly cooked and bleached, broadleaved wood pulps can form papers with high burst and tensile strength, in certain cases as high as those from coniferous pulps. The tear resistance, however, is generally lower, and high folding strength difficult to obtain.

Due to the short fiber length, the sheet formation properties of broadleaved wood pulp are excellent. Short fiber broadleaved pulps are therefore preferred in blends when producing book, printing, and fine papers.

Table II. Illustrative Uses for Main Groups of Paper

Type of paper	Uses
Newsprint	Newspapers
Magazine and 2nd quality book paper	Magazines, catalogues, telephone directories, pamphlets, folders, and books; base paper for machine coating
Book paper, 1st quality	Books, offset, lithograph
Fine paper, 1st quality	High quality printing paper, bond, ledger and writing, bristol (rag papers are not included)
Fine paper, 2nd quality	Bond and writing papers with lower brightness and generally lower strength than those mentioned above, also tablet
Wrapping, 1st strength	Kraft paper, multiwall bags
Wrapping, 2nd strength	Most kinds of wrappings and bag papers, combination board liner
Wrapping, 3rd strength	Wrapping paper requiring only low strength, and building paper
Greaseproof	Greaseproof, glassine, and tracing
Kraftliner	Liner for corrugating container board and combination board
Corrugating medium	Corrugating medium and center ply in combination board

Nonwood Plant Fibers[27]

Based roughly on chemical composition, fiber dimensions, texture of raw material, and ease of pulping, those plants that have received most industrial attention as raw materials for pulpmaking fall into the five groups shown below:

Group	Plants chiefly used as pulp sources
Straws and grasses	Wheat, rye, rice, esparto, sabai
Canes and reeds	Sugarcane bagasse, cornstalk, *Arundo donax, Phragmites communis*
Woody stalks with bast fibers	Flax, jute, hemp (*Cannabis*), soybean and cotton stalks' castor stems
Leaf fibers	Abaca (manilla), sisal, henequen, pineapple, caroa
Bamboos	Various varieties

Variations in fiber dimensions and approximate variations in principal chemical components of these plants are listed in Table I.

As is well known, the bast and leaf fibers are much longer than those of any other groups. Bamboos possess fibers

[27] Much of this discussion and the tables were taken from the report by E. C. Lathrop, "The Characteristics of Pulp Fibers from Agricultural Residues," *Tropical Woods and Agricultural Residues as Sources of Pulp*, p. 143, FAO, Rome, 1952.

Table III. Possible Uses of Spruce, Fir, Hemlock, and Araucaria Pulp

Type of paper	Groundwood: Ubl	Groundwood: Sbl	Chemical: Sulphite: Ubl	Chemical: Sulphite: Bl	Chemical: Sulphate: Ubl	Chemical: Sulphate: Sbl	Chemical: Sulphate: Bl
Newsprint	†B	..	*A	..	..	*A	..
Magazine and 2nd quality book paper	•BD	•D	•A	•A	..	•A	•A
Book paper, 1st quality	*D	*D	..	†A	..	..	†A
Fine paper, 1st quality	..	..	..	†E	..	..	•E
Fine paper, 2nd quality	*BDE	*DE	•ADE	†DE	..	..	†ADE
Wrapping, 1st strength	..	..	..	..	Δ	Δ	Δ
Wrapping, 2nd strength	*	..	†	..	•	•	..
Wrapping, 3rd strength	•	..	•[a]	..	•[a]	..	..
Greaseproof	..	..	Δ	Δ	..	..	•
Kraftliner	*	..	..	..	Δ	..	..
Corrugating medium	•	..	•[a]	..	•[a]	..	..
Rayon and cellophane	..	..	..	Δ	..	..	Δ[b]

[a] Screenings.
[b] Prehydrolyzed.

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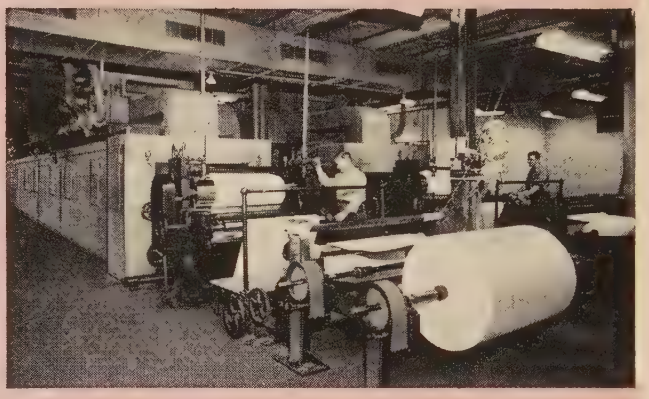

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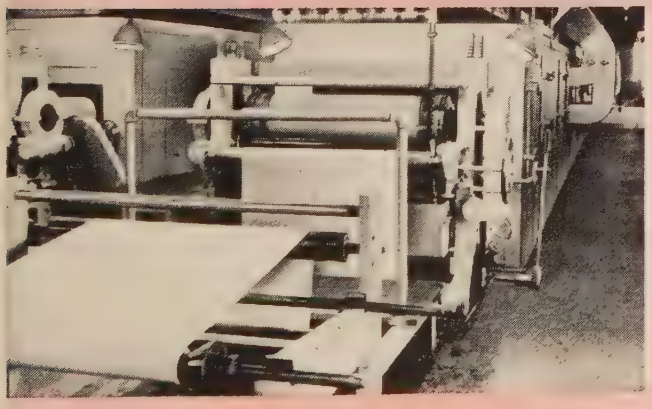

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Table IV. Possible Uses of Pine[a] and Douglas-Fir Pulp

Type of paper	Groundwood[b] Ubl	Groundwood[b] Sbl	Sulphate Ubl	Sulphate Sbl	Sulphate Bl
Newsprint	†B	..	..	*A	...
Magazine and 2nd quality book paper	..	•BD	..	•A	•A
Book paper, 1st quality	..	*D	..	..	†A
Fine paper, 1st quality	..	..	..	..	†DE
Fine paper, 2nd quality	..	..	..	..	•ABDE
Wrapping, 1st strength	..	..	Δ	Δ	Δ
Wrapping, 2nd strength	..	..	•	..	...
Wrapping, 3rd strength	..	..	•[c]	..	...
Greaseproof	..	..	..	..	•BD
Kraftliner	..	..	Δ	..	...
Corrugating medium	•	..	•[c]	..	...
Rayon and cellophane	..	..	..	..	Δ[d]

[a] In only a few cases is the sulphite process used for certain pines.
[b] Certain pines only.
[c] Screenings.
[d] Prehydrolyzed.

of substantially the same length as coniferous woods. As pointed out before, long fibers produce high tear resistance in papers. Straw and bagasse have shorter fibers which are of the same order of magnitude as those of temperate broadleaved woods. Fibers of the woody stems of plants in group 3 are very short and unsuited, except possibly under certain circumstances.

From the data given in the table it will be noted that annual plants contain much more ash than temperate woods. Bast and leaf fibers are low in lignin content; in bamboo and the woody stems of plants producing bast fibers, however, lignin content is as high as in hardwoods (25%) but in bagasse and straw it is lower (19%). These differences are reflected in the amounts of chemicals required for pulping and bleaching.

Alpha-cellulose content is highest in the bast and leaf fibers, decreasing in the following order: bamboo, wood, stalks, and straw.

The table also classifies the various groups of fibers in relation to texture. Materials in group 1 are easiest to pulp because of the very open plant structure and their relatively low lignin content. The open structure and thin walls of the straws present a large initial surface for chemical attack and minimize the problem of diffusion. The pulping reaction is therefore rapid and the amount of chemicals required for pulp production is generally lower than with other fibers.

Next in order come sugarcane bagasse and then reeds. They require more chemicals and more vigorous pulping conditions, owing to the fact that the rind fibers of these plants are usually denser and the fiber walls thicker than those plants encountered in group 1.

Bast and leaf materials frequently present a problem in pulping because of associated impurities, but such fibers isolated by mechanical methods—being very low in lignin and high in cellulose—pulp with greater ease and with less chemical requirements than pulpwoods, bamboos, and the fibers of woody stems.

From the fibers in groups 1 and 2 (e.g., straws, bagasse, and reeds) it is possible to make greaseproof and glassine papers possessing good transparency or resistance to grease and oil. The tear resistance of such papers might be improved by blends of coniferous wood or other long fiber pulps. Writing or printing, bond, ledger, and book papers may be made from such fibers, but fillers are generally required to obtain the desired opacity. They are, however not suitable for strong wrapping and bag papers, but if mixed with coniferous wood pulps they can be used for many qualities. Unbleached semichemical pulps are well adapted for corrugating medium.

When blended in suitable proportion with coniferous wood pulps, straw and bagasse fibers will improve sheet formation, surface characteristics, and printability. They can be recommended for use in papers such as writing and printing papers. They may replace part of the coniferous wood sulphite in newsprint and magazine book papers, where the addition of well-hydrated agricultural residue pulps increases strength and improves formation.

Suitability of Short Fiber Pulps for Newsprint, Kraft Wrapping, and Container Board

The kinds of paper required in largest tonnage—newsprint, kraft wrapping, and container board, have been developed entirely from coniferous woods. Adaptation of other fibrous raw materials for the manufacture of these products is more difficult than it is for practially all other kinds of paper.

Newsprint is being made from groundwood pulp and up to 20% coniferous wood chemical pulp (either unbleached sulphite or semibleached sulphate). Since groundwood pulp is made by the simplest process and is obtained in the highest yield it is the least costly of any of the pulping processes in industrial areas. As mentioned earlier, most newsprint groundwood is made from conifers. Of all the broadleaved woods, only aspen and eucalypts are used at the present time. A few other broadleaved species may produce a suitable quality for conventional practice but most, particularly the heavier ones, do not

Some possibilities for using heavy broadleaved woods for newsprint have been indicated in small-scale demonstrations. Various combinations of low strength broadleaved wood groundwood—used in smaller proportions than is customary in combinations with semichemical pulps—have produced

Table V. Possible Uses of Temperate Broadleaved Pulp

Type of paper	Groundwood Ubl	Groundwood Sbl	Semichemical: Cold caustic soda Ubl	Semichemical: Cold caustic soda Sbl	Semichemical: Hot caustic soda, Ubl	Semichemical: Neutral sulphite Ubl	Semichemical: Neutral sulphite Bl	Chemical: Sulphite Ubl	Chemical: Sulphite Bl	Chemical: Sulphate[a] Ubl	Chemical: Sulphate[a] Bl
Newsprint	•B[b]	..	..	†	..	•A	..	*A	..	..	*A
Magazine and 2nd quality book paper	•BD	•D	..	•BD	..	..	•A	..	•A	..	•A
Book paper, 1st quality	..	•D	..	..	..	..	..	..	•AD	..	•AD
Fine paper, 1st quality	..	..	..	..	..	..	†D	..	†D	..	†D
Fine paper, 2nd quality	..	*	..	..	..	..	†AD	..	†AD	..	..
Wrapping, 1st strength	..	..	..	..	..	..	..	..	..	•C	..
Wrapping, 2nd strength	..	..	..	..	..	•C	..	•C	..	†C[c]	..
Wrapping, 3rd strength	..	..	*	..	*	†	..	†	..	•A	..
Greaseproof	..	..	..	..	..	Δ	Δ	Δ	Δ	..	..
Kraftliner	..	..	..	..	..	*C	..	..	..	•C	..
Corrugating medium	..	..	Δ	..	Δ	Δ	..	..	..	..	..
Rayon and cellophane	..	..	..	..	..	..	..	..	Δ	..	Δ[d]

[a] Soda pulps from temperate broadleaved woods are still being made in some mills. The percentage of such pulp used in fine papers would normally be less than shown for the sulphate pulps from the same species.
[b] Only *Populus* species.
[c] Especially for light weight sheets.
[d] Prehydrolyzed.

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Table VI. Possible Uses of Eucalypt Pulp

Type of paper	Groundwood Sbl	Semichemical: Cold caustic soda Ubl	Semichemical: Cold caustic soda Sbl	Semichemical: Hot caustic soda, Ubl	Semichemical: Neutral sulphite Ubl	Semichemical: Neutral sulphite Bl	Chemical: Sulphite Ubl	Chemical: Sulphite Bl	Chemical: Sulphate Ubl	Chemical: Sulphate Bl	Chemical: Soda Bl
Newsprint	†B	..	†B	..	..	..	..	..	..	..	..
Magazine and 2nd quality book paper	•BD	..	•BD	..	..	..	..	..	..	..	..
Book paper, 1st quality	..	..	*BD	..	..	..	..	†	..	†	†
Fine paper, 1st quality	..	..	..	..	..	..	..	•D	..	†	†
Fine paper, 2nd quality	..	..	..	..	..	..	..	†	..	..	..
Wrapping, 1st strength	..	..	..	..	..	..	..	..	•C	..	..
Wrapping, 2nd strength	..	..	..	..	•BC	..	•C	..	†C	..	..
Wrapping, 3rd strength	..	•BC	..	•BC	Δ	..	Δ	..	Δ	..	..
Greaseproof	..	..	..	..	..	†	..	..	..	..	..
Kraftliner	..	..	..	..	•C	..	..	..	•C	..	..
Corrugating medium	..	Δ	..	Δ	Δ	..	..	..	..	..	..
Rayon and cellophane	..	..	..	..	..	..	..	Δ	..	Δ[a]	..

[a] Prehydrolyzed.

papers of the newsprint type. One example is a combination of 50% unbleached birch semichemical, 30% birch groundwood, and 20% spruce groundwood. Other combinations including broadleaved wood chemical pulps or small proportions of coniferous wood chemical pulp are also possibilities. For the same raw material costs, however, such combinations would be more expensive than the conventional furnish.

One of the most promising possibilities for the use of broadleaved woods for newsprint is offered by the cold caustic soda treatment. A number of broadleaved woods—both light and heavy—have produced groundwood-type pulps that are quite satisfactory. Although these pulps tend to give dense sheets, it has been possible to produce acceptable paper on a small scale from them. Blends with longer fiber pulps appear desirable. Bleaching is probably essential in most instances to meet standard brightness values.

These results indicate the possible usage of broadleaved woods for newsprint-type papers. Use of the heavier broadleaved woods for all or the greater part of the composition, although more difficult, is also a possibility.

Since it is not possible to make groundwood-type pulp from straw, bagasse, and similar plant fibers, conventional newsprint cannot be made entirely from these materials. Magazine-type papers of good quality can be made from chemical pulps derived from such materials.

Chemical pulps made from straw or bagasse could be utilized as a substitute for coniferous wood chemical pulps, used in combination with groundwood for newsprint. Also, they could be combined with deinked waste news.

In localities where long-fibered kraft is not produced there is an increasing tendency to use sulphate pulps or even good grades of semichemical pulps from broadleaved wood—and certain pulps from agricultural residues—for multiwall bag papers. In Australia, for example, it is reported that 40% eucalyptus sulphate is mixed with 60% imported kraft for cement bag paper and still higher percentages of eucalyptus pulp are used for lower grade wrapping paper. The addition of long-fibered kraft increases the tearing strength, which in 100% broadleaved wood papers is generally too low.

Semichemical broadleaved wood pulps and agricultural residue pulps are used normally today for the stiff medium of corrugating board. In some places even the top liner board is made successfully from broadleaved wood pulps alone, although the strength properties of such a product may not correspond to U. S. standard, where 100% long-fibered kraft is normally used.

Table VII. Possible Uses of Tropical Broadleaved Mixture Pulp

Type of paper	Groundwood[a] Ubl	Groundwood[a] Bl	Semichemical: Cold caustic soda Ubl	Semichemical: Cold caustic soda Bl	Semichemical: Hot caustic soda, Ubl	Semichemical: Neutral sulphite, Ubl	Sulphate Ubl	Sulphate Sbl	Sulphate Bl
Newsprint	†B	..	..	†B	..	..	..	*A	*A
Magazine and 2nd quality book paper	•BD	•D	..	•BD	..	..	..	•A	*A
Book paper, 1st quality	*DE	*DE	..	..	..	..	..	..	†
Fine paper, 1st quality	..	..	..	..	..	..	..	..	†
Fine paper, 2nd quality	*BD	*BD	..	*BD	..	..	..	..	•A
Wrapping, 1st strength	..	..	..	..	..	..	•C	..	..
Wrapping, 2nd strength	..	..	..	..	..	..	Δ	..	..
Wrapping, 3rd strength	*	..	•BC	..	•BC	•BC	•A	..	..
Kraftliner	..	..	..	..	..	..	•C	..	..
Corrugating medium	..	..	Δ	..	Δ	Δ	..	..	..
Rayon and cellophane	..	..	..	..	..	..	..	..	Δ[b]

[a] Only cetico, parasolier (*Musanga Smithii*) and similar species.
[b] Prehydrolyzed.

Table VIII. Possible Uses of Straw and Bagasse Pulp

Type of paper	Hot lime, Ubl	Soda and sulphate Ubl	Soda and sulphate Bl	Neutral sulphite Ubl	Neutral sulphite Bl	Caustic soda-chlorine Ubl	Caustic soda-chlorine Bl	Mechanochemical Ubl	Mechanochemical Bl
Newsprint	..	..	*A	..	*A	..	*A	..	*A
Magazine and 2nd quality book paper	..	..	•ABE	..	•ABE	..	•ABE	..	•ABE
Book paper, 1st quality	..	..	•ABDE	..	•ABDE	..	†ABDE	..	•ABDE
Fine paper, 1st quality	..	..	†DE	..	†DE	..	†DE	..	†DE
Fine paper, 2nd quality	..	..	†	..	†	..	†	..	†
Wrapping, 1st strength	..	..	...	*C	...	*C	...	*C	...
Wrapping, 2nd strength	..	*BC	...	•BC	...	•BC	...	•BC	...
Wrapping, 3rd strength	..	†	...	†	...	†	...	†	...
Greaseproof	..	..	•B	..	†	..	†	..	†
Kraftliner	..	*C	...	•C	...	•C	...	•C	...
Corrugating medium	Δ	Δ	...	Δ	...	Δ	...	Δ	...

The Emerson Jordan Plug Pressure Control and Recording System ★

a Automatically maintains predetermined pressure between plug and shell knives, eliminating manual resetting.

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Division of John W. BOLTON & Sons, Inc.

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Table IX. Possible Uses of Bamboo Pulp

Type of paper	Semichemical: Hot caustic soda, Ubl	Semichemical: Neutral sulphate, Ubl	Semichemical: Neutral sulphate, Bl	Chemical: Sulphite, Bl	Chemical: Sulphate, Ubl	Chemical: Sulphate, Bl
Newsprint	..	..	..	..	..	•A
Magazine and 2nd quality book paper	..	..	..	•AB	..	•ABD
Book paper, 1st quality	..	..	..	†D	..	†
Fine paper, 1st quality	..	..	..	†D	..	†
Fine paper, 2nd quality	..	..	..	•A	..	•AE
Wrapping, 1st strength	..	..	..	..	•C	..
Wrapping, 2nd strength	•BC	•BC	..	..	Δ	..
Wrapping, 3rd strength	•A	•A	..	..	•A	..
Greaseproof	..	•B	•BDE	..	..	..
Kraftliner	*C	*C	..	..	•C	..
Corrugating medium	Δ	Δ	..	..	..	..
Rayon and cellophane	..	..	..	..	..	Δ[a]

[a] Prehydrolyzed.

Specific Uses of Various Pulps

Tables III to IX illustrate the possible uses of pulps produced by different processes from the various types of raw materials discussed in this report. The kinds of paper represented as end products for which the pulps are used are divided into four main groups: newsprint and magazine, book and fine paper wrapping, and container board.

Each of the groups is further subdivided—largely according to quality—which is indicated in Table II.

Introduction to Tables III to IX

The symbols given in Tables III to IX indicate the amount of pulp which can be used for different purposes in the following ways:

* up to 20%
• from 20 to 60%
† from 60 to 90%
Δ 100%

After the symbols one or more block letters (A, B, C, D, E) are given to indicate the kind of pulp which has to be blended, in accordance with the following key:

A. Groundwood
B. Unbleached coniferous sulphite
C. Unbleached coniferous kraft
D. Bleached coniferous chemical pulp, sulphite or sulphate
E. Bleached broadleaved chemical pulp

In addition, the following abbreviations are used:

UBl = Unbleached Sbl = Semibleached Bl = Bleached

Where several of these pulps are indicated, it means that one of them or perhaps mixtures of them may be used. In many cases, and particularly for low-grade papers, no additional pulp is given, thus indicating that the choice may be between several pulps, and often not only among those listed above (A–E). The symbol (†), without additional pulp being shown indicates that the main part of the furnish is made up of the pulp in question and that the remainder may either be the same pulp (that is, equal to 100%) or, and perhaps better, another type of pulp. It is quite obvious that many difficulties arise in attempting to simplify and generalize a complicated problem in this way. The information given, therefore, should be considered only as approximate and indicative of possibilities.

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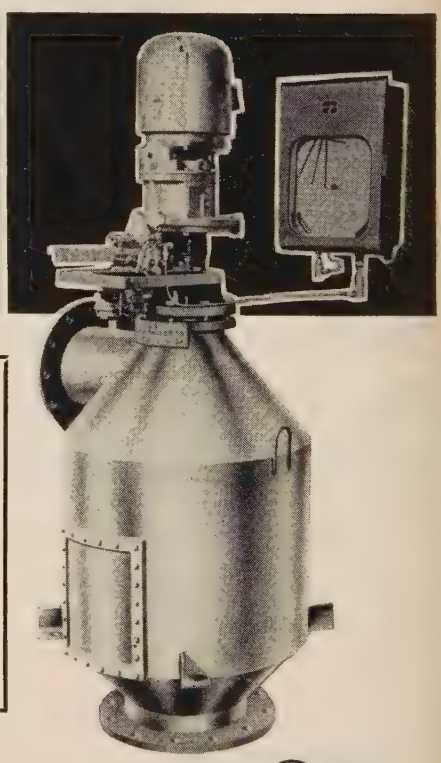
SPECIFY DeZURIK AUTOMATIC - RECORDING CONSISTENCY REGULATORS



DeZurik Stock Consistency Regulators are fully automatic in operation. Three basic types provide the correct answers to any consistency control problems: Pipe Line type (illustrated) is used on closed systems; Stuff Box type is installed ahead of open type stock meters, paper and board machines, wherever an open box can be used; Pan type is designed to take a gravity flow from washers, deckers, save-alls, etc., without the necessity of pumping the stock.

The DeZurik Closed Stock System is an engineered, mill-proved, package unit that eliminates five specific points of air pickup common to conventional stuff box installations. The entire system remains full of stock from the machine chest to the fan pump or mixing box. No overflows—no stuff gates—no partly-filled stock pipes . . . . no "bubble trouble!" Placing the basis weight control-valve at a much lower level in the system than a conventional stuff-box gate results in more uniform basis weight. Thus any changes in stock level at the stuff-box will have much less effect on the amount of stock delivered.

ACCURATE
Holds regulated consistency within plus or minus .1%.

SIMPLE
A single knob sets the regulated consistency.

SENSITIVE
Instantaneous response to changes in consistency. Unaffected by spattering stock.

DURABLE
Superior construction of non-corrosive metals.

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Wide range of box designs available.

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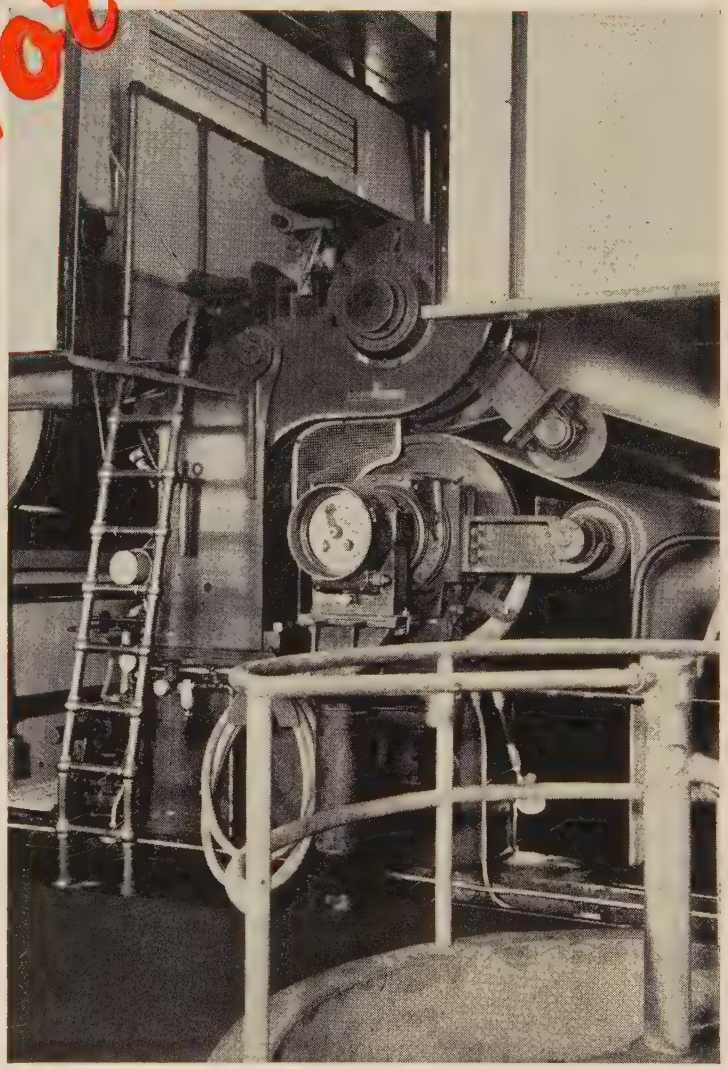
KEEPS A RECORD AROUND the CLOCK

NEW Downingtown Suction Hot Press



Photograph of Downingtown Suction Hot Press recently installed in dryer section of #6 machine at Longview Fibre Co., Longview, Wash. This press tells the story.

Another Downingtown First—increases by 33⅓% dryness of an already well pressed, test liner sheet.

Before installation of Downingtown Suction Hot Press—sheet entered dryers at 815 FPM and 31% dry after an efficient suction couch and two suction presses.

After installation of Downingtown Suction Hot Press—(so called because of location in dryer section) sheet entered main dryer section 41% dry. Consequently speed increases are permitted.

This unbelievable increase in dryness is due to a combination of features, including engineered felt and paper runs, suction box size, roll diameters, use of predryers and nip pressure of 500# lin. in.

Contingent advantages include reduced refining horsepower, higher Mullen test.

Learn the entire story about the Downingtown Suction Hot Press from your Downingtown Sales Engineer. Write, wire or call.

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2. You get dependable engineering—For 95 years Johns-Manville has been accumulating insulation engineering experience. J-M Insulation Engineers are called upon to solve insulation problems of every type and magnitude, in every industry. Since your J-M Insulation Contractor works closely with J-M Insulation Engineers, he brings to *every* job a high degree of training, skill and experience.

3. You get dependable application—Johns-Manville has set up a nationwide organization of J-M Insulation Contractors to serve you. These Contractors maintain staffs of insulation engineers as well as skilled mechanics thoroughly trained in J-M's proved application methods. You can have absolute confidence in their ability to apply J-M insulations correctly for trouble-free performance.

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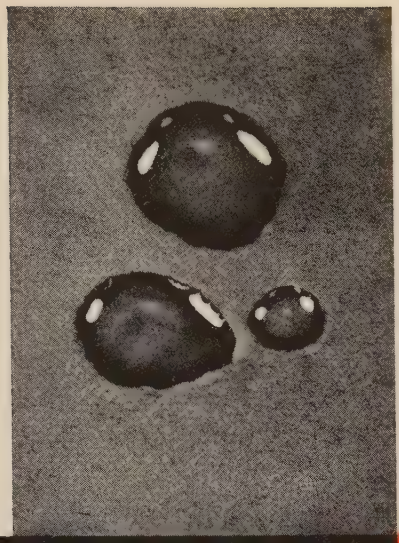

This unretouched photograph shows a 1% solution of Kelsize twenty minutes after being puddled on blotter. Note how solution remains on surface of blotter. This test illustrates that the filming properties of Kelsize or Kelgin hold water on the surface fibers longer thus providing better lubricating action during calendering. This permits more smoothing action by calender rolls before penetration of aqueous solutions occur.

SMOOTHER SMOOTHNESS WITH KELGIN or KELSIZE

THIS BLOTTER TEST SHOWS WHY KELGIN AND KELSIZE SOLUTIONS MAKE PAPER AND PAPERBOARD SMOOTHER DURING CALENDERING.

Here is unretouched photograph of water, without Kelsize, on piece of same blotter, taken seconds after water was placed on blotter. Note how water has immediately passed into blotter compared to controlled penetration of Kelsize solution. Proof that Kelsize and Kelgin are superior surface control agents.

Due to their colloidal and film forming properties Kelgin and Kelsize also contribute the following improvements:

1. Control penetration of adhesives, starch solutions and most water base solutions.
2. Improved smoothness and finish.
3. More uniform printing surface.
4. Higher and more uniform Gloss and Flat Ink Printing.

   Increased oil, wax and varnish resistance.

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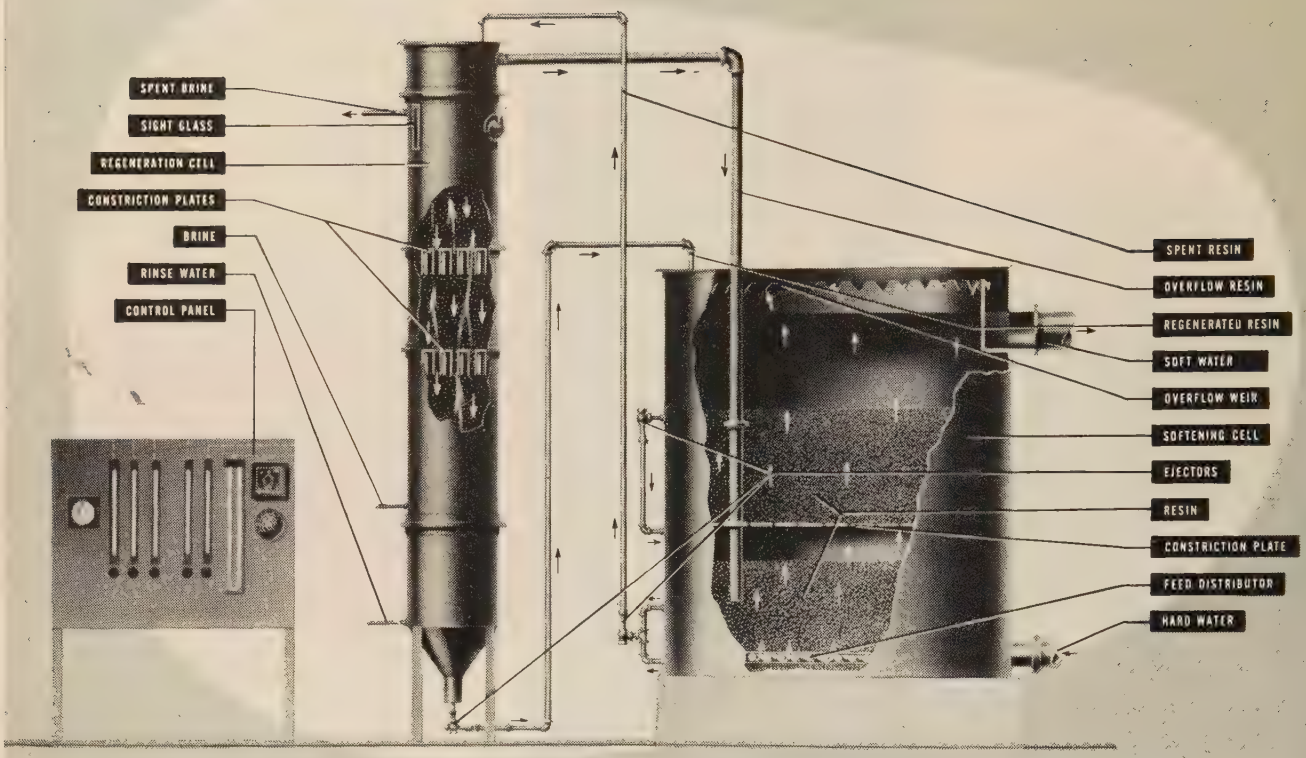

Illustrative drawing of the Dorrco Hydro-Softener. Note that regeneration is carried out in a separate tank from the softening cell to minimize danger of contaminating treated water.

New! Base Exchange Softening Goes Continuous...

Here's the Dorrco Hydro-Softener . . . the new *exclusive development* that puts both the softening cycle and regeneration cycle on a 100% continuous basis. There's no shutting down to regenerate and rinse . . . no periodic slug discharge of high content brine to contaminate the stream . . . but a continuous supply of soft water at a constant quality.

What's more, installed cost of the Hydro-Softener is lower than with a conventional batch cation exchange softener and more efficient regeneration and lower rinse water requirements add up to lower operation costs.

If you'd like more information on this new development in water treatment practice, drop a line to The Dorr Company, Stamford, Conn. Bulletin No. 4083, just off the press, describes the Dorrco Hydro-Softener in detail. A copy is yours for the asking.

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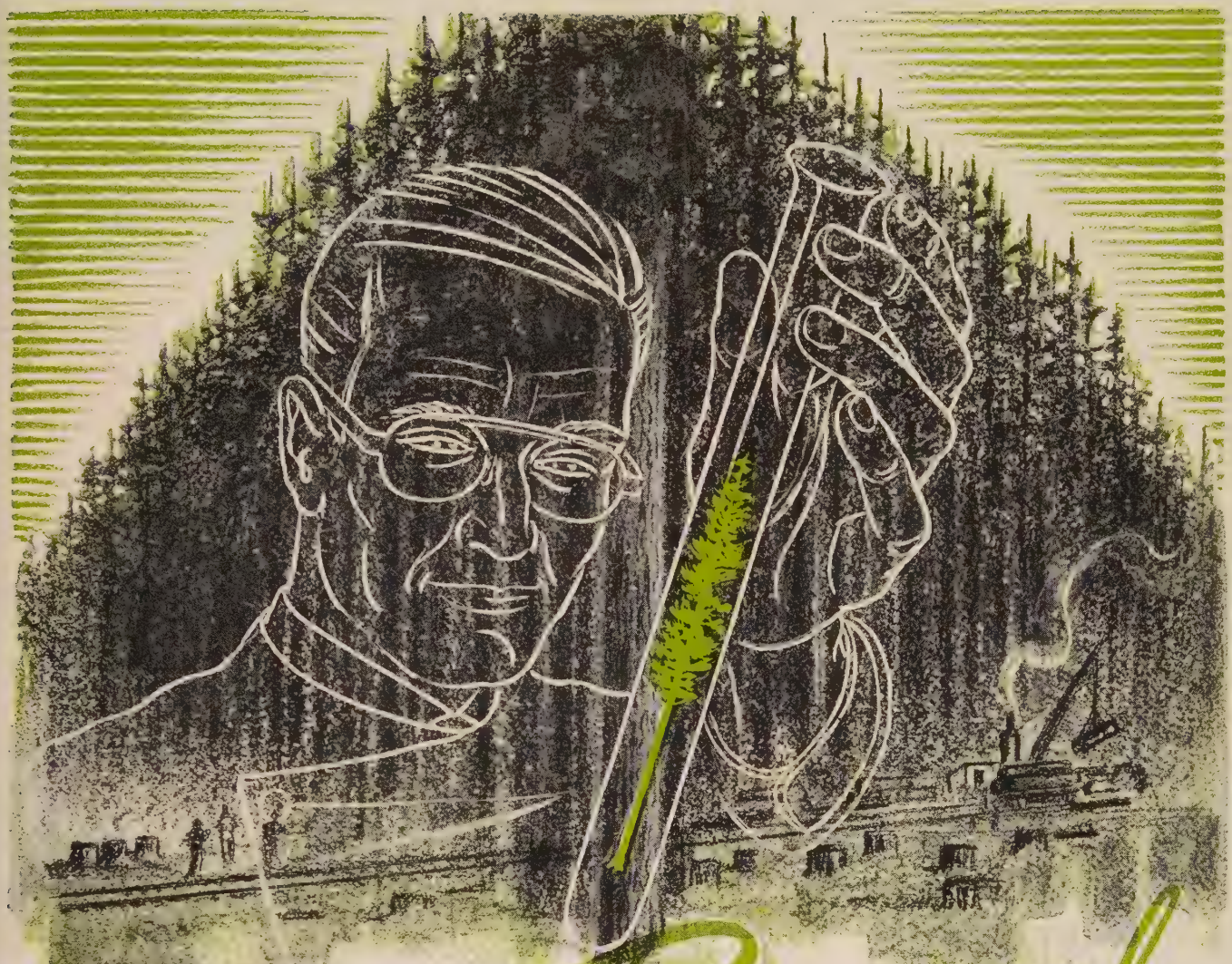

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Weyerhaeuser researchers devote constant effort toward finding better means to efficiently process woodpulp for papermakers in a competitive market. Stronger, better fibres result in paper and paper products unequalled for their superiority in either domestic or foreign competition. Woodpulp research is moreover carried on so that more *new* products from woodpulp can be economically manufactured.

Indeed, from woodpulp to paper is merely part of the story. From pulp to cellophane, photographic film, sausage casings, lacquers, plastics, smokeless powder, and endless other products would still not give the whole picture. Researchers are every day developing significant new products from woodpulp to improve our living.

It is therefore clear why the Weyerhaeuser Timber Company, through its research facilities and its scientific methods of tree farming and manufacturing, is dedicated to supply—without interruption—the woodpulp that industry requires.

PULP DIVISION

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Monsanto Introduces: A Complete Dry Fortified Size . . .

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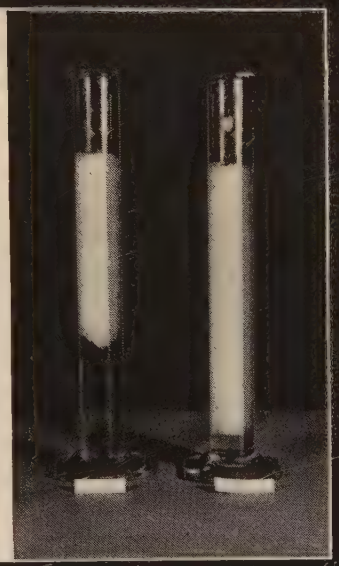
WITH LOW FOAM INDEX

Compare Mersize RM Dry with any Other Dry Size

① LOW FOAM

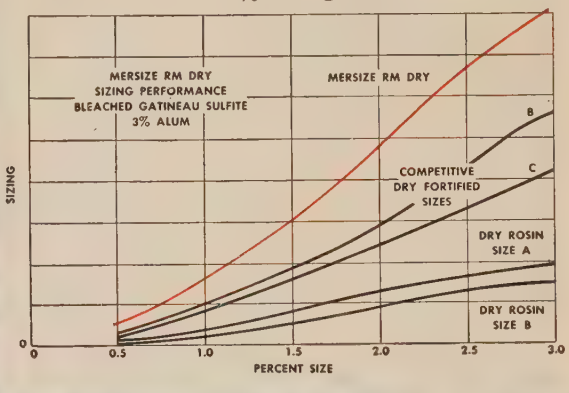
Mersize RM Dry produces less foam than any other size—fortified or rosin—on the market. Here is a typical comparison:

Size	Foam Index
Mersize RM Dry	10
Competitive Size B	70
Competitive Size C	40
Competitive Size D	25
Competitive Size E	20



② HIGH EFFICIENCY

Compared in this graph with competitive dry rosin and fortified sizes, RM Dry is substantially more efficient. Mill trials confirm this. In a typical trial, 0.85% of Mersize RM Dry gave sizing equal to that obtained with 1% of competitive product B on sulfite bond—a 15% saving.



③ FAST DISSOLVING

Mersize RM Dry dissolves readily even in cold water, faster than the fine-powder sizes.

In photo, 3% of RM Dry and a competing dry size have been stirred into cold water. After five minutes, the Mersize (left) has completely dissolved while the other size solution remains cloudy.

④ LIGHT COLOR

Mersize RM Dry is very light in color and resists darkening upon aging. Its solutions are clear and light.

Mersize RM Dry therefore gives high-brightness paper, comparable to the lightest rosin size, and gives paper with better lightfastness than other sizes.

LOW DUSTING . . . HIGH DENSITY

Your beater room men will appreciate Mersize RM Dry. It is low in dusting—equal to the best of previous products—and is less sticky . . . you save as much as 20% in storage space, because it is more dense than competing dry sizes.

Monsanto—the originator of fortified sizes—has added another outstanding product to its line of pale fortified sizes in Mersize RM Dry.

Mersize CD-2—concentrate, for use with rosin size
Mersize CD-2 Dry—concentrate in dry form
Mersize RM 70%—complete fortified paste size
Mersize RM 77%—complete fortified paste size

Call any Monsanto office for a trial order now. *Write* us for technical literature on Mersize RM Dry. Organic Chemicals Division, MONSANTO CHEMICAL COMPANY, Box 478, St. Louis 1, Missouri.

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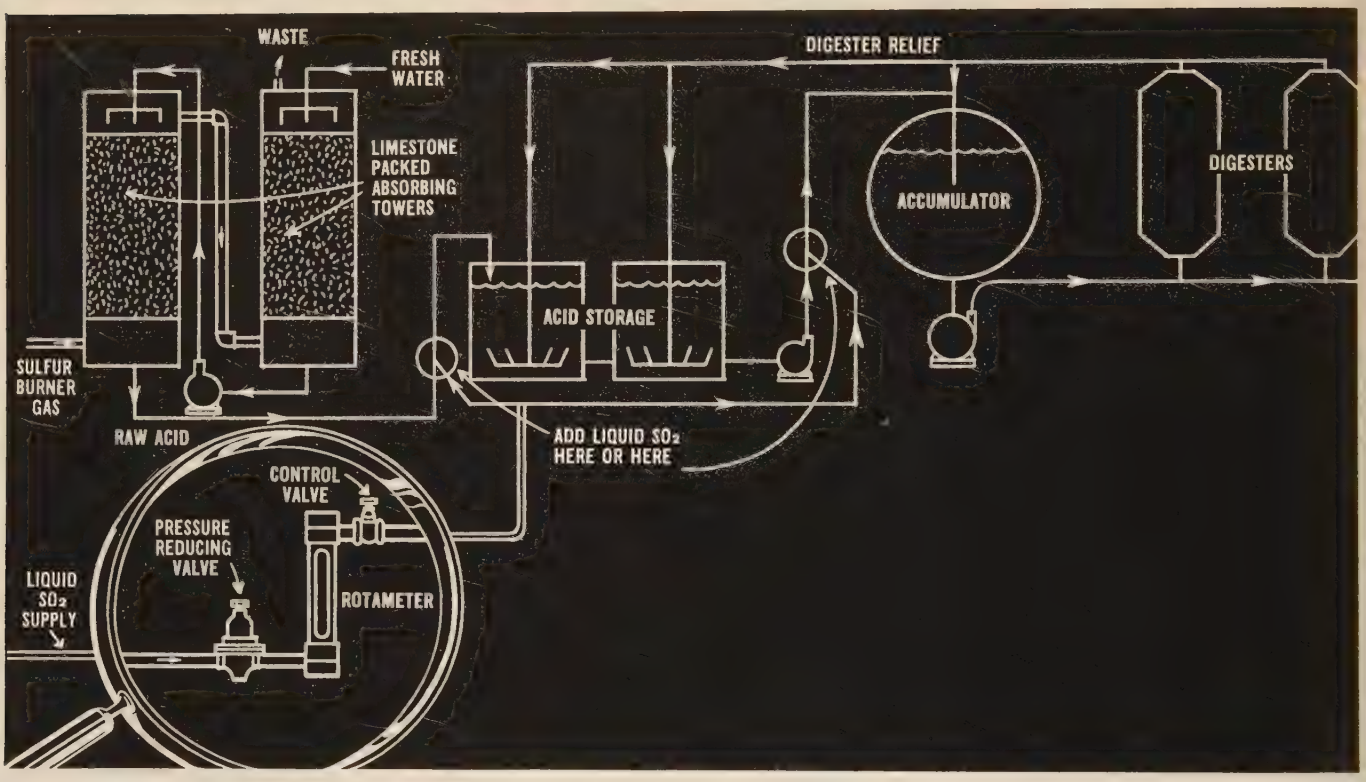

with easy-to-operate

Ansul sulfur dioxide system

Installing an Ansul sulfur dioxide system is the sure, economical way to cut cooking time and keep sulfite pulp production going at an even rate *in spite of* wet or green wood cooks, high water temperatures or other hard-to-control variables.

Adding free sulfur dioxide to the acid supply gives faster wood chip penetration thereby increasing the rate of pulping. The increased pulping rate gained by adding free sulfur dioxide permits a considerable reduction in the pulping temperature for a constant digestion time. This cuts fuel costs and increases quality because lower temperatures give higher yields and improved chemical and physical properties to the finished product.

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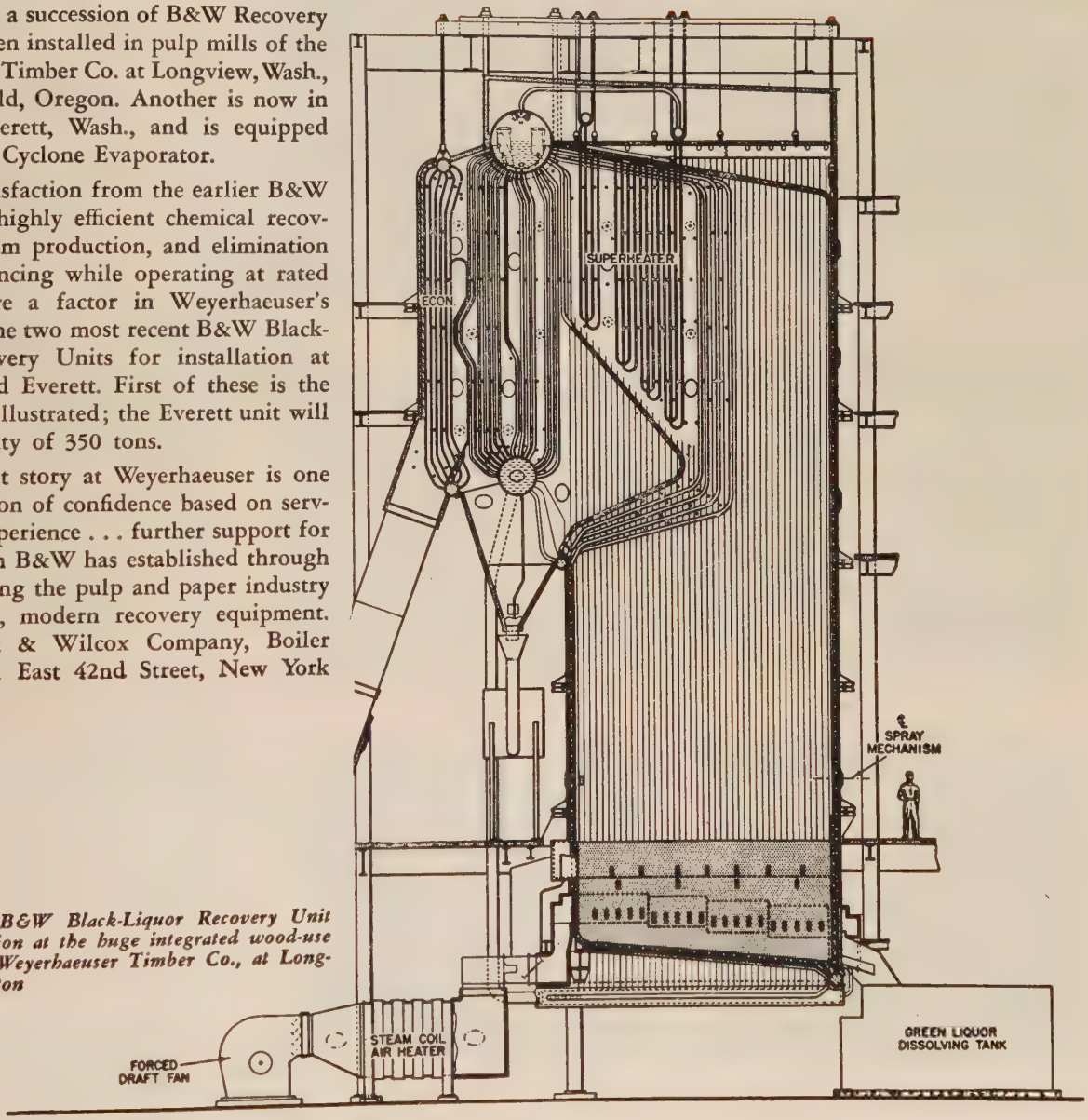
6 B&W RECOVERY UNITS SERVE 3 MILLS OF WEYERHAEUSER

PULP DIVISION

Since 1945, a succession of B&W Recovery Units have been installed in pulp mills of the Weyerhaeuser Timber Co. at Longview, Wash., and Springfield, Oregon. Another is now in service at Everett, Wash., and is equipped with a B&W Cyclone Evaporator.

Service satisfaction from the earlier B&W Units—their highly efficient chemical recovery, high steam production, and elimination of routine lancing while operating at rated capacity—were a factor in Weyerhaeuser's selection of the two most recent B&W Black-Liquor Recovery Units for installation at Longview and Everett. First of these is the 300-ton unit illustrated; the Everett unit will have a capacity of 350 tons.

This repeat story at Weyerhaeuser is one more indication of confidence based on service-proved experience . . . further support for the reputation B&W has established through years of serving the pulp and paper industry with efficient, modern recovery equipment. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

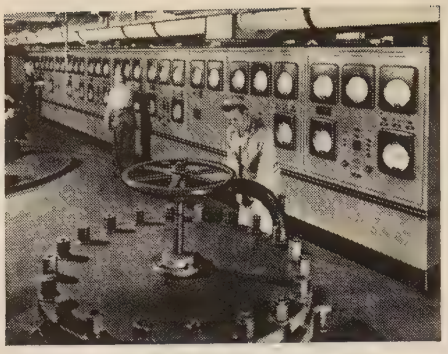


New 300-ton B&W Black-Liquor Recovery Unit now in operation at the huge integrated wood-use center of the Weyerhaeuser Timber Co., at Longview, Washington

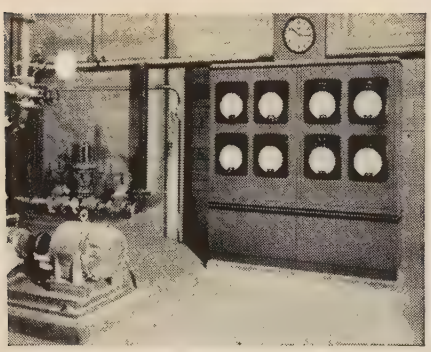
BABCOCK & WILCOX

P-783

Alkaline Pulp Digester Control
Riegel Carolina Corp.



Sulphite Pulp Digester Control
Weyerhaeuser, Pulp Div.



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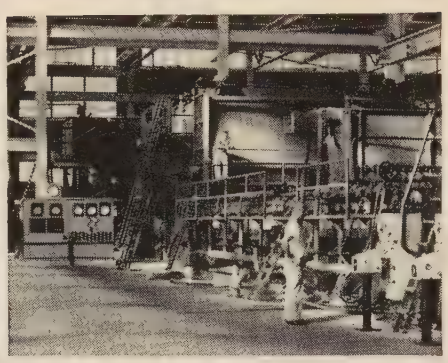

Paper Machine Wet End Control
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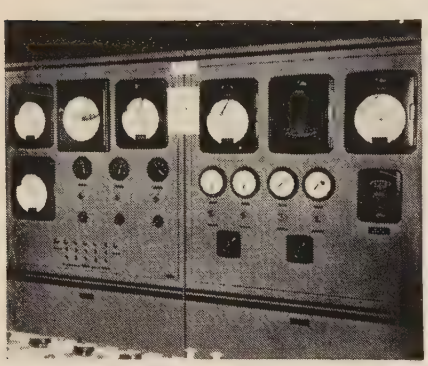

Pulp Drying Control
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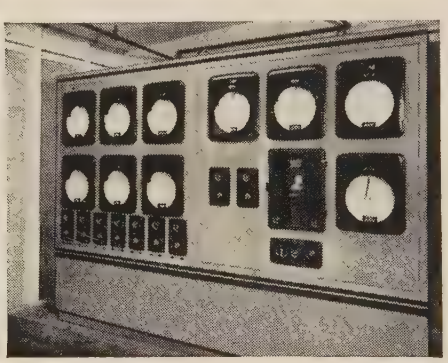

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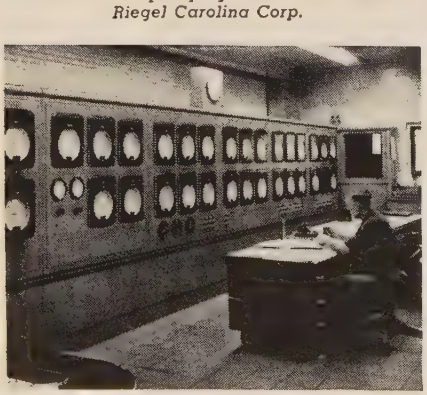

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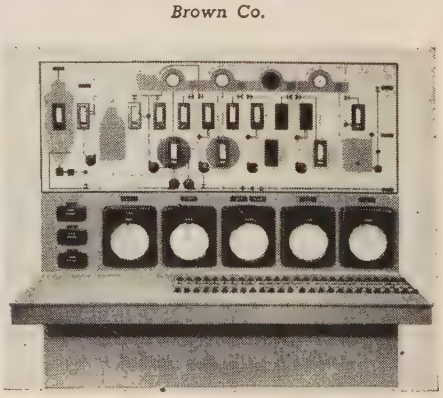

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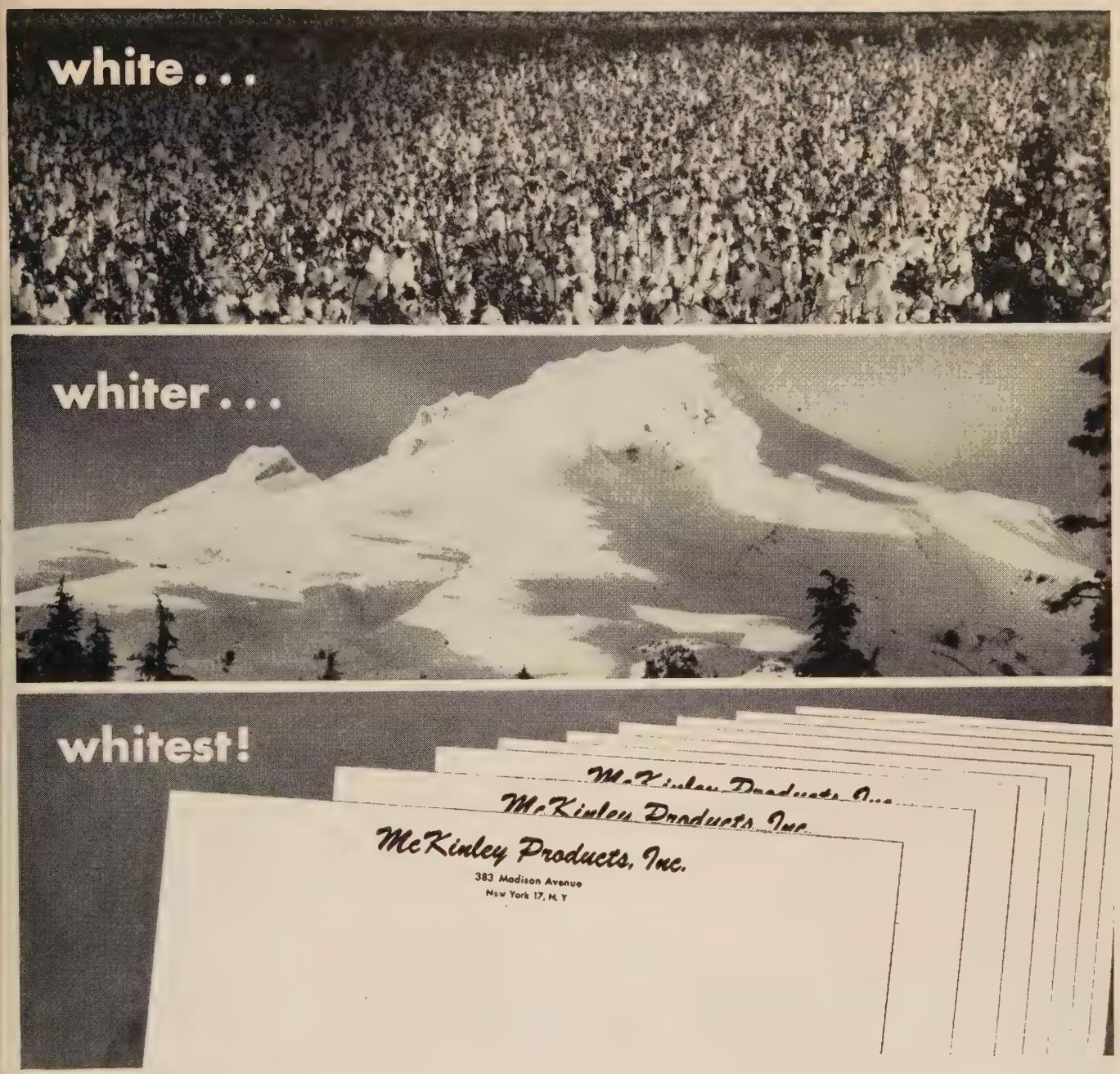

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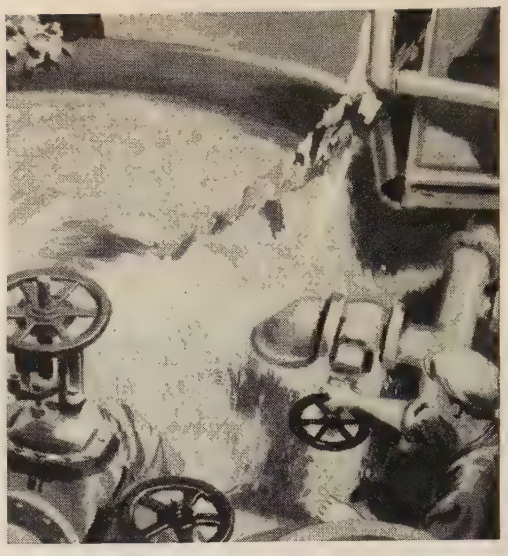

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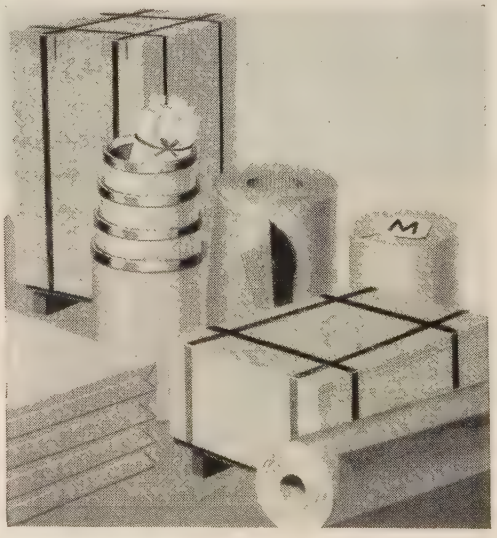

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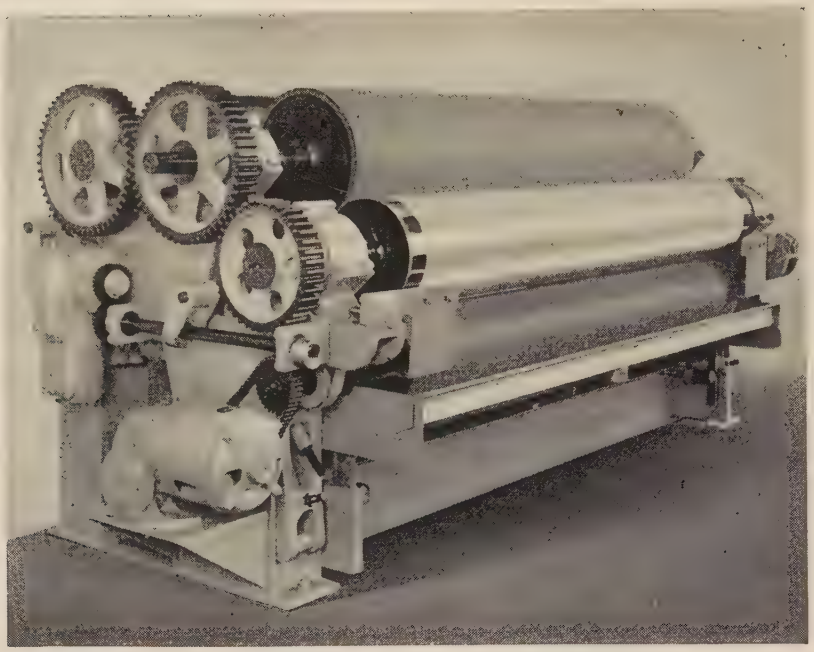

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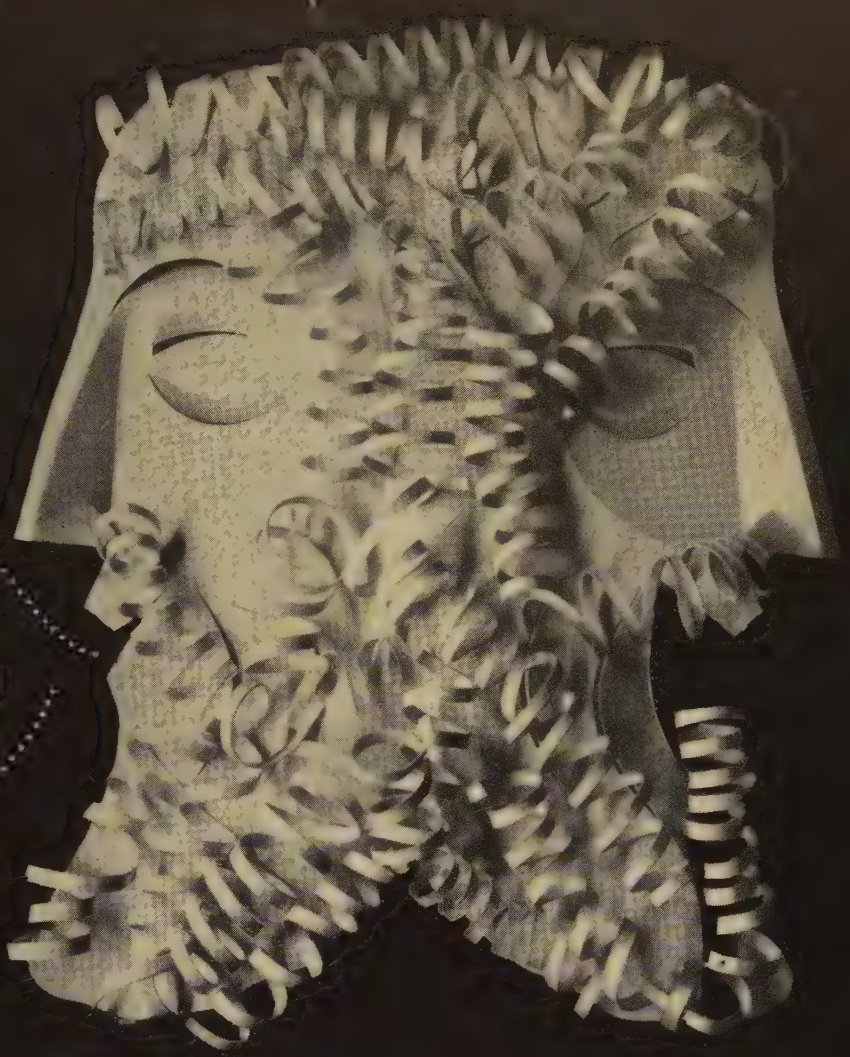

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An Investigation of Methods for Dimensionally Stabilizing Paper

F. W. LOREY and C. E. LIBBY

It was found that basis weight had no effect on the expansion of handsheets with increases in humidity nor did fiber size, except when the fibers were very coarse and greater expansion occurred. Freeness also had no effect except at high freenesses where the pulp was bulky and expansion greater, but sheets subjected to high pressures showed less expansion. The application of heat to wet handsheets decreased the expansion of the dried sheets with increases in humidity, but beater addition of a clay filler had no effect. Dimensional changes of sheets formed from sulphite pulp increased as the purity of the pulp increased, and sheets made from hardwood pulps expanded to the same extent as sheets made from softwood pulps. Silicone and rosin sizes, added by beater addition, did not decrease the dimensional changes of handsheets with changes in humidity. Neoprene-treated handsheets showed decreases in expansion with increases in humidity as the addition of neoprene was increased above 20%. When thermosetting resins were applied by impregnation, the handsheets showed less expansion with increases in humidity, and of the resins investigated, phenol-formaldehyde, thiourea-formaldehyde, and glyoxal-cellosize exhibited optimum effects in the order listed. Urea, a plasticizing agent, showed a negative effect and increased the dimensional changes with changes in humidity.

PAPER responds to changes in humidity, but the effect is relatively small and usually of little importance. For some uses of paper, however, close dimensional control is desirable and among these are coated abrasive papers which have a coating of high polymeric material that acts as a binder for abrasive particles on one side of the sheet. This binder substance expands to a lesser extent than paper with changes in humidity and the resulting strains cause curling of the abrasive paper. Machine-sorted classification cards and offset printing papers are other examples where close dimensional control is desirable.

In this investigation, the physical characteristics of handsheets such as basis weight, fiber dimensions, freeness, and density were examined with respect to their influence on dimensional changes with changes in humidity. Finally, various chemicals such as sizing agents, thermosetting resins, neoprene, and urea were added to handsheets in an attempt to decrease the dimensional changes with changes in humidity.

LITERATURE SURVEY

Among the technical papers which describe instruments for measuring dimensional changes of paper with changes in humidity is that of Griffin (*1*). The "expansiometer" described has the paper strip suspended vertically between jaws in a capped glass tube, with the bottom jaw activating a lever arm which moves along a graduated scale. Roberts (*2*) determined expansion by measuring the changes directly, as did Larocque (*3*) who used a cathetometer. Another is Van den Akker (*4*) who describes a satisfactory method of measuring these changes by means of a direct reading calibrated dial. The strips were suspended vertically and kept taut by means of a spirit level, which also served the purpose of enabling the end of the strip to be returned to its original position, thereby measuring the changes. Koester (*5*) has patented an apparatus consisting of a pointer and a multiplying mechanism, whereby the dimensional effects of relative humidity upon paper samples may be determined and recorded. Hamburger (*6*) describes an instrument comprised of a directly connected indicating device for a vertically suspended strip, and a hair hygrometer for measuring humidity. An instrument which records dimensional changes of vertically suspended strips by means of an optical lever has been described by Weber and Geib (*7*). Bialkowsky and Probst (*8*) placed paper strips horizontally in glass tubes and observed the differences by means of a measuring micrometer. Several authors (*9*, *10*) used the TAPPI Standard device (T 447 m-45), the principle of which was used in this investigation.

Data available in the literature on the magnitude of dimensional changes are difficult to compare, because the measurements were made at different ranges of humidity changes. Hamburger (*6*) found an offset paper to change two and one-half times as much in the cross direction as in the machine direction. Griffin (*1*) using a relative humidity range of 0 to 100% found for a wide variety of papers a cross direction change of 1.1 to 1.8% and a machine direction change of 0.35 to 0.85%. In addition, the change from 80 to 100% R.H. was greater than from 60 to 80% R.H. Reed (*11*) worked with changes in relative humidity of 35 to 65% and listed values for coated papers where the cross direction changes were two to three times as great as the machine direction changes, while for offset papers the changes were four to eight times greater. For ranges of 25 to 65% R.H., Larocque (*3*) found the dimensional changes in bond papers to be 0.40% for the cross direction and 0.12% for the machine direction, and noted a hysteresis effect. Bialkowsky and Probst (*8*) working in a relative humidity range of 15 to 95% found the expansion of bond papers to be 0.6% in the machine direction and 1.6% in the cross direction. They further observed that in the range of 15 to 50% R.H. the changes in each direction were about the same, while in the range of 50 to 95% R.H. the cross direction expanded about seven times as much as the machine direction.

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When subjecting paper to a change in humidity, equilibrium is reached between the humidity of the air and the natural humidity of the fibers in 1 to 3 hr., depending on the thickness of the sheet, type of pulp, degree of sizing, and porosity of the sheet according to an anonymous author (*12*). Klemm (*13*) states that practically all papers have the same rate of moisture pickup. Larocque (*3*) adds that rates of extension and adsorption of newsprint are much greater than for glassine and attributes the difference to the variation in density. Depending on sheet weight, Reed (*11*) says that 1 to 2 hr. are needed to reach equilibrium when increasing the relative humidity from 35 to 65%, and adds that roughly 1% moisture is gained for every 10% rise in relative humidity. Houston, Carson, and Kirkwood (*14*) and Klemm (*13*) agree in stating that the rate of moisture change is rapid during the first few minutes, and the moisture content is close to equilibrium long before the equilibrium state is reached in about 2 hr. McKee and Shotwell (*15*) concluded that the rate of moisture change varies with the difference between the moisture content already present and that which would be present if the sheet and moisture were in equilibrium. Observations by Griffin (*1*) indicate that equilibrium is reached in a much shorter time when working from low to high humidities than when working from high to low humidities.

There is little in the literature on the use of additives in decreasing the dimensional changes of paper. Griffin (*1*) found that wax, forming a moisture vapor barrier on paper, decreases the expansion of the paper with increasing humidity and that very little expansion occurs below 60% R.H. Larocque (*3*), to the contrary, states that a waxed paper that he tested showed the same expansion as nontreated papers, other than glassine and greaseproof which showed a greater expansion for a relative humidity increase of 25 to 65%. Griffin also observed that coated papers gave lower expansion results.

A few observers have reported the use of resins in decreasing the dimensional changes of paper. Scribner, Shaw, O'Leary, and Missimer (*9*) claim that the beater addition of 1 to 3% of melamine-formaldehyde resin to hardwood fibers caused a decrease in expansion of the resultant sheet with a 15% R.H. increase, but their published data did not justify this conclusion. The data of O'Leary, Scribner, and Missimer (*10*) indicate that beater additions of 1 to 3% melamine-formaldehyde had variable effects on expansion, while clay fillers either cause a slight decrease in expansion or have no effect. Watson and Anderson (*16*) patented a process whereby 2 to 3% by weight of urea-formaldehyde or phenolic resins are added by impregnation to impart dimensional stability to paper. Stearn (*17*) obtained a patent which employs a 10% thiourea-formaldehyde solution applied in the same way and claims to obtain a 50% decrease in expansion with increases in humidity, without developing brittleness.

Harrison (*18*) acetylated pulps and showed that both the hygroscopicity and "hygroexpansivity" of paper from these pulps decreases as degree of substitution increases. "Hygroexpansivity" as explained by Tarkow (*19*) is a term coined by The Institute of Paper Chemistry to describe the dimensional changes of paper with changes in humidity.

Dimensional changes of paper are directly dependent on dimensional changes of the fibers making up the sheet.

Weidner (*20*) states that fiber dimensions are definitely dependent on the humidity of the air from 0 to 95% R.H., and found that hysteresis in fiber width and moisture content exists and remains unchanged after the original desorption. Seborg (*21*) observed the same effect. Both of these authors found an irreversible loss in hygroscopicity to occur during the initial desorption, and the effect was illustrated by the data of Weidner obtained for sulphite fibers working in the range of 0 to 95% R.H. On the first desorption the change in length was 1.5 to 1.6% and the change in width 9.0 to 9.6%, while on subsequent adsorptions and desorptions the change in length was 0.8% and the change in width 7.4 to 8.3%. Clayton and Pierce (*22*) found that from 0 to 40% R.H. the increase in fiber dimensions was 0.04% in length and 0.14% in width per unit increase in relative humidity. Collins (*23*) in measuring cotton in the range of 0 to 100% R.H. found an 11% change in width and a 1% change in length. Weidner (*20*) noticed that above 60% R.H. fiber diameters increased rapidly, but dimensions of fibers in water and at equilibrium with 95% R.H. were not appreciably different.

The literature indicates that the change in volume on swelling, up to the fiber saturation point is not equal to the volume of water adsorbed. Weidner (*20*) found that the moisture content and swelling showed fair correlation up to 60%, above which the moisture content increased more rapidly than the fiber swelling. He thus concluded that cellulose has a coarse capillary structure for holding water in addition to a fine capillary structure which affects the swelling of the fiber. Stamm (*24*) showed that the size of fiber cavities change very little on swelling and shrinking.

Beating decreases the swelling of the fiber on adsorption, according to Weidner (*20*), who obtained a decrease in swelling of 25% by beating sulphite pulp to a Schopper-Riegler freeness of 650. Although the swelling of beaten fibers decreases, the moisture adsorption is increased, as shown by Russell, Campbell, and Maass (*25*). An explanation of this phenomenon is offered by Weidner who says that beating loosens the fibrillar structure of the fiber so that moisture is adsorbed into the voids, with the effect of decreasing the over-all expansion.

The effect of fiber composition on fiber expansion is noted by several authors. Weidner (*20*) noticed that overcooked and bleached sulphite fibers have larger widths at all humidities than normally cooked, unbleached fibers, which may be due to the removal of lignin. Young and Rowland (*26*) found there was a linear behavior between the swelling of softwood pulps and their pentosan content, but for hardwood pulps the relationship was not so marked. Bixler (*27*) noted that alkaline pulps swell much more than sulphite pulps, because the secondary walls are intact due to the selective action of the alkaline liquors, whereas the secondary walls of sulphite fibers are partially removed in pulping.

There are considerable data in the literature on the decrease of fiber swelling through the application of heat. Weidner (*20*) found that swelling on moisture

adsorption is decreased 50% by heating the fibers at 103°C. for 2 hr. He explains that this result is caused by the formation of more permanent bonds due to greater shrinkage, and on adsorption the swelling is inhibited by these bonds. According to Jayme (*28*) pulp shows an irreversible hardening on drying, and Jayme and Rothamel (*29*) observed that hemicelluloses play an important part in this effect. Tarkow (*19*) emphasizes that the use of drying to decrease hygroscopicity is limited because of loss of strength and toughness due to degradation. Decrease in fiber swelling through the heating of pulp suspensions was observed by Jayme (*28*).

Doughty (*30*) stresses that the elements of sheet formation are fiber arrangement, formation (open or closed, wild or uniform), and solid fraction (density), and the literature shows that variation in any of these elements affects the dimensional changes of paper with changes in humidity. The curling of paper with changes in humidity is attributed by Papineau-Couture (*31*) and Hanson (*32*) to the higher density on the felt side of the sheet than on the wire side. The felt side then expands more across the sheet, due to fiber alignment, with an increase in humidity, and the sheet curls, with the wire side concave and the axis of the curl in the machine direction. Roberts (*2*) adds that bleached pulp shows greater curl and that anything that increases shrinkage, such as beating, increases curl. Swanson (*33*) claims that papers of lower density, higher porosity, and better formation might be expected to show lower changes in external dimensions with changes in humidity, because of the greater opportunity for expansion and contraction of the fibers within the voids of the sheet, and Tarkow (*19*) agrees that true swelling is not all transmitted to the external dimensions. Swanson adds that a decrease in the dimensional changes of paper may be affected by decreasing mechanical refining. No mention is made in the literature about relocation and relative movement of fibers on changes in humidity, other than the observation of Tarkow (*19*) and many others that moisture has an effect on the interfiber bonds. Bialkowsky and Probst (*8*) found that basis weight had no effect on expansion, and that expansion is not changed when a furnish of all long-fibered stock is varied with respect to the type of pulp.

EXPERIMENTAL PROCEDURE

Unbleached sulphate pulp, supplied by the Brompton Paper Co. of Quebec, Canada, was used in this investigation. Other types of pulp were also used but only for determining the effect of pulp type on dimensional changes.

A Niagara beater of 1.5 lb. capacity was used for beating and beater addition of chemicals, with a load of 6.5 kg. on the beater roll. Dried pulp was dispersed and then added to the beater, equivalent to 400 grams on the moisture-free basis. The consistency in the beater was made up to 2% with tap water, except for the sizing operations where distilled water was used. When the desired freeness was reached, the roll weight was removed and the pulp was either immediately removed and formed into sheets or the beater additive and precipitant were first added, depending on the phase of the investigation.

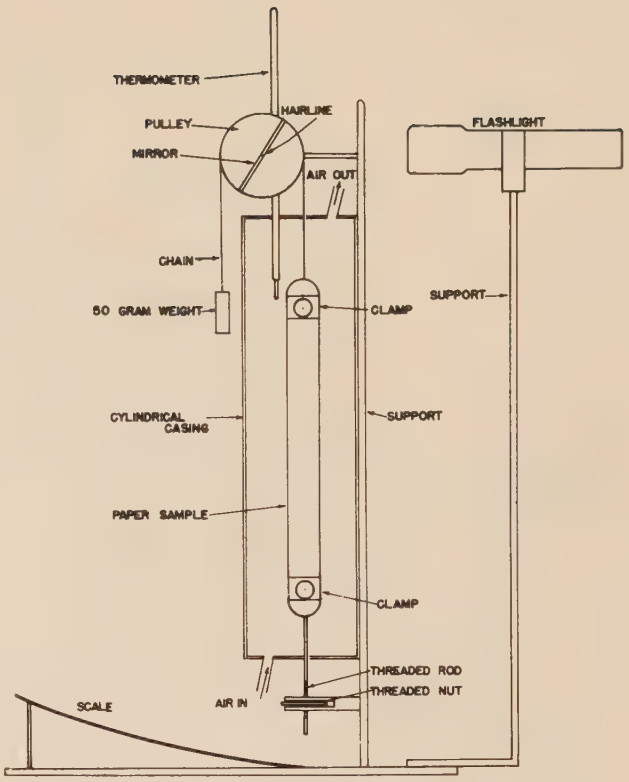

Fig. 1. Diagram of expansimeter

A British Standard sheet mold was employed in forming the handsheets, and the mold was equipped with a bronze gear pump for recycling the white water. When making sheets containing additives, a sufficient amount of stock for the sheets was removed from the beater, and the white water was drained from the remaining pulp by filtering through cheesecloth. A part of the white water was used to dilute the stock for the sheets, and another part was poured into the sheet mold. The same white water was used in the mold to dilute the pulp for each sheet by recycling the water through the gear pump from a sealed sump tank below the mold. Fresh water was used to dilute pulps having no additives.

The handsheets formed were of TAPPI Standard basis weight of 42.7 lb. (25 × 40—500). In those experiments using beater additives, the first five sheets formed were heavier than the others and therefore discarded, so as to build up the white water system and insure equilibrium.

Pulp blotters were used in removing the sheets from the mold and the sheets were placed against chrome drying plates prior to pressing. The other surface of the sheet was in contact with a blotter during pressing unless otherwise stated. Sheets pressed at low values were processed in a Williams sheet press, while higher pressures were obtained with a hydraulic press having a maximum load of 20,000 p.s.i. Unless otherwise stated, the sheets were pressed at maximum pressure of 50 p.s.i. for 5 min., after a 2-min. rise.

The sheets were removed from the blotters after pressing, and while still adhering to the chrome plates were clamped in drying rings which prevented the sheet from shrinking while drying. The drying was conducted at room temperature when not otherwise stated, or in a forced-air circulation oven at elevated tempera-

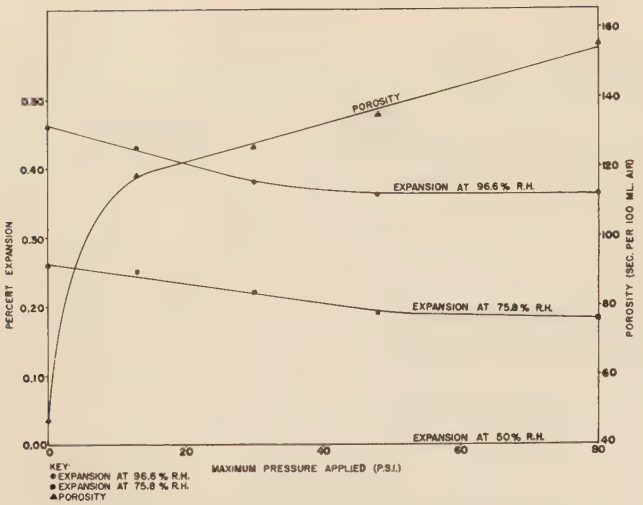

Fig. 2. Expansion versus maximum pressure applied; porosity versus maximum pressure applied

tures, depending on the phase of the work being investigated.

In those phases of the investigation where additives were introduced by impregnation, TAPPI Standard handsheets were prepared as mentioned above. The sheets were dipped for 10 min. in various concentrations of the additives and then squeezed with a clothes wringer at set pressure. They were then pressed between chrome plates, without blotters, to 50 p.s.i. in 30 sec. and maintained at this pressure for another 30 sec., after which they were dried in sheet rings under prescribed conditions.

The resin retained in the sheet was determined by weighing the sheet before and after dipping at standard humidity conditions of 50% R.H. and 73°F. The resin percentages were calculated from the resin weight at standard humidity conditions and the moisture-free weight of the pulp.

All handsheets were conditioned for at least 24 hr. at standard humidity room conditions of 50% R.H. and 73°F. before testing.

An expansimeter or instrument for measuring changes in surface dimensions of paper with changes in humidity, was constructed specially for this work. The device is shown in Fig. 1. A strip of paper is suspended between two jaws which are located 5.5 in. apart and which are enclosed in a cylindrical copper chamber. The bottom jaw is stationary, while the top jaw is suspended on a chain that rides on a pulley and carries a weight of 50 grams on the opposite end. Perpendicular to a diameter of the pulley is a mirror which reflects light onto a scale at the base of the instrument. Air passes into the cylindrical chamber at the bottom and leaves at the top.

A piece of paper 1 in. wide is placed in the instrument and fastened between the jaws at the prevailing humidity of the paper testing room which is 50% R.H. Air at a humidity of 75.8% R.H. is then supplied by passing compressed air through a saturated sodium chloride solution, after which a 96.6% R.H. is obtained by passing air through a saturated potassium sulphate solution. The elongation in thousandths of an inch of the $5^1/_2$-in. strip is read directly from the scale at the base of the instrument and then converted and recorded as the percentage increase. Three expansion tests were performed on each sample with the reported value

Table I. Effect of Sheet Weight on Expansion

Basis weight, lb. (25 × 40—500)	*Per cent expansion at 75.8% R.H.*	*Per cent expansion at 96.6% R.H.*
10.5	0.19	0.39
21.0	0.19	0.38
42.0	0.18	0.36
53.0	0.18	0.36
116.0	0.17	0.36
210.0	0.16	0.36

being an average of the three results. The device for measuring relative humidity was simply an enclosed wooden box with wet and dry bulb thermometers.

The Cobb sizing test (TAPPI Standard T 441 m-45) was used to measure degree of sizing. Fifty milliliters of distilled water were used in the Cobb instrument and the time of exposure of the sheet to the water was 3 min., including 15 sec. for removing excess water by blotting. The amount of water absorbed by the 100 sq. cm. of paper surface exposed was reported as the Cobb size value of the sheet.

Porosity was determined with the Williams S-P-S tester, and the values reported are the seconds required for the passage of 100 ml. of air. The porosity results differed depending on which side of the handsheet faced the source of air, with the values being higher when the glossy side of the sheet (that dried in contact with the chrome plate) faced the source of air. Porosity values were obtained with the rough side of the sheet facing the air supply.

Other values measured were ash content according to TAPPI Standard T 413 m-45, basis weight according to TAPPI Standard T 410 m-45, and folding endurance according to TAPPI Standard T 423 m-50.

DISCUSSION OF RESULTS

Effect of Sheet Weight on Expansion

Pulp was beaten to a freeness of 190 (Canadian Standard) and sheets varying in weight from 10.5 to 210 lb. (25 × 40—500) were made and tested for expansion. The results are presented in Table I.

The heavier sheets took a longer time to reach equilibrium, but the expansion results were in the same range as those of the lighter sheets, although the lighter sheets showed slightly higher expansion.

Effect of Fiber Dimensions on Expansion

Pulp was beaten to a freeness of 70 (Canadian Standard) and then passed through a Bauer-McNett fiber

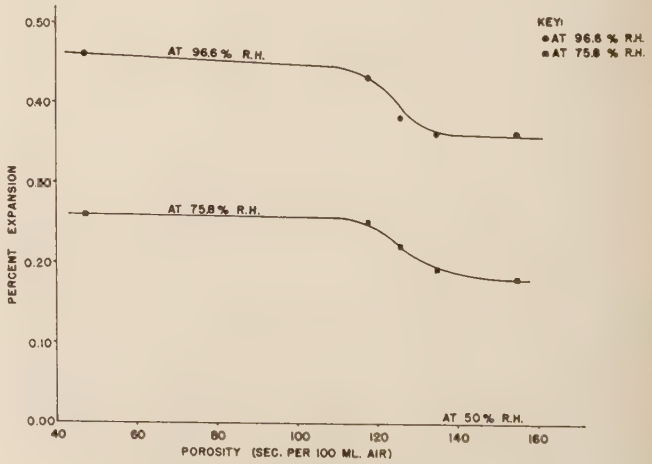

Fig. 3. Porosity versus expansion

Table II. Results of Fractionating Beaten Sulphate Pulp

Sample	Classification of fibers	Percentage of total sample
A	Retained by 20-mesh screen	38.0
B	Passed 20-mesh, retained by 35-mesh	23.4
C	Passed 35-mesh, retained by 65-mesh	8.5
D	Passed 65-mesh, retained by 150-mesh	10.7
	Passed 150-mesh, and went to sewer	19.4
	Total	100.0

classifier in standard 10-min. runs, using 10 grams for each run. Forty runs were made in order to obtain sufficient pulp of each dimension to make handsheets. For convenience the samples were labeled A to D, and Table II shows how the original pulp separated into fractions of different fiber classifications and the percentage of each fraction obtained from the total sample.

Sheets containing only fibers of a single classification or combination of two classifications were made and tested. The results are presented in Table III.

Except for sheets composed wholly of fibers retained by the 20-mesh screen (A), there are no definite trends shown by these results. The sheets containing only 20-mesh pulp were bulkier and had poorer fiber-to-fiber bonding than the other sheets, and therefore stretched more under high humidity and the tension of the 50-gram weight. The sheets made wholly of 20-mesh pulp had a caliper of 0.004 in., while the other sheets averaged 0.0034 in.

Effect of Pulp Freeness on Expansion

Pulp was beaten in a Valley beater with samples removed at 15-min. intervals, tested for freeness, and formed into sheets from which expansion was determined. The results are shown in Table IV.

The results of these tests indicate that freeness, except at extremely high values, has no effect on the dimensional changes of handsheets at varying humidities. The pulp at 618 freeness undoubtedly made less dense sheets with poorer fiber-to-fiber bonding than the slower pulps.

To the contrary, Swanson (*33*) claims that dimensional changes of paper with changes in humidity increase with increases in density, such as that produced by beating. Tarkow (*19*) agrees, and Bialkowsky and Probst (*8*) show that greater shrinkage on drying, and thus higher density, increases the changes in cross-directional dimensions with changes in humidity. Other authors (*2*, *31*, *32*), in dealing with the curling of paper, agree with the findings of Bialkowsky and Probst in that higher density increases the changes in

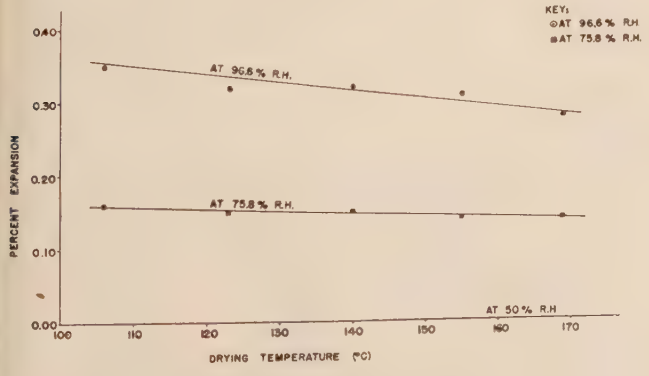

Fig. 4. Expansion versus drying temperature

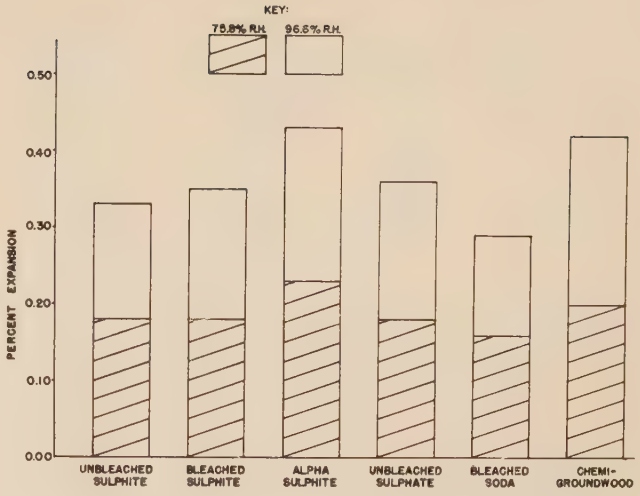

Fig. 5. Expansion of various pulp types

cross-directional dimensions. Thus, it is fairly certain that the dimensional changes of machine-made papers with changes in humidity, especially in the cross direction, increase with decreases in pulp freeness.

The fiber arrangement in handsheets, as compared to machine-made papers, offers a suitable explanation as to the difference in the effect of beating on the dimensional changes of each type of paper. Fibers in machine-made papers are arranged predominantly in the machine direction and when fiber expansion occurs the fibers push against adjacent fibers, and therefore increase the cross-directional dimensions of the sheet. This effect is amplified by the higher density and increased fiber bonding due to beating since the fibers are closer together and have more of a chance of pushing against one another. With handsheets the fibers are arranged in random fashion and comparatively very few fibers lie adjacent to one another. Therefore, upon swelling the increase in fiber dimensions serves primarily to close the sheet voids rather than push other fibers, and increased fiber bonding due to beating has little effect.

Effect of Wet Pressing on Expansion

Sheets were pressed while wet with each sheet having a chrome plate adjacent to one surface and a blotter in contact with the other. Two minutes were consumed in bringing the sheets to the desired maximum pressure which was then maintained for 5 min. Tests for porosity as well as expansion were performed on the sheets and the results are presented in Table V.

The foregoing results indicate that expansion decreases with an increase in wet pressure. The relation-

Table III. Effect of Fiber Dimensions on Expansion

Fiber composition of test sheet	Thickness of sheet, thousands of an in.	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
100% A	4.0	0.29	0.64
100% B	3.5	0.18	0.36
100% C	3.4	0.18	0.36
100% D	3.3	0.21	0.40
50% A—50% B	3.4	0.19	0.37
50% A—50% C	3.4	0.16	0.33
50% A—50% D	3.4	0.16	0.35
50% B—50% C	3.3	0.18	0.36
50% B—50% D	3.3	0.17	0.35
50% C—50% D	3.3	0.18	0.36

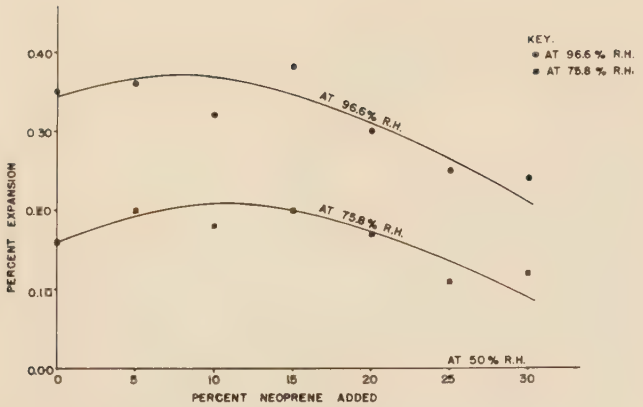

Fig. 6. Expansion versus per cent neoprene added to handsheets

ships between maximum pressure, expansion, and porosity shown in Figs. 2 and 3 indicate that very good correlation of results were obtained. No explanation can be made for the shape of the curve in the plot of expansion versus porosity in Fig. 3. Sheets were then subjected to higher pressures and the results obtained are shown in Table VI.

As shown in Table VI, porosity results were not proportional to the pressure applied to the sheets. Porosity and expansion, however, show some correlation with the results indicating that expansion decreases with increased porosity.

The foregoing results definitely indicate that a dense handsheet, and thus a sheet with a high degree of fiber bonding, has better dimensional stability than a less dense sheet with the same fiber characteristics but a lesser degree of fiber bonding. These results are diametrically opposite to those obtained with machine-made papers, as described in the literature by Swanson (*33*) and several other authors (*8, 19, 30, 31, 32*). The different results with handsheets are probably due to the random distribution of the fibers, as compared to the unidirectional arrangement of the fibers in machine-made papers.

This evidence obtained with handsheets gives proof that dimensional changes with varying humidity are in part due to interfiber relationships, because the dimensional changes decreased on wet pressing when fiber swelling remained unaffected. With increased density and firmer fiber bonding the fibers do not move as far apart as they swell with increased moisture.

Effect of the Beater Addition of a Filler on Expansion

This effect was determined by the beater addition of clay. To simulate papermaking conditions, 2% rosin was added to the pulp followed by the clay in various quantities and 3% alum. The sheets were pressed at 50 p.s.i. for only 30 sec. to promote increased retention of the filler, and then dried at 115°C. for 1 hr. The results are shown in Table VII.

Table IV. Effect of Pulp Freeness on Expansion

Pulp freeness, ml. (C.S.)	*Per cent expansion at*	
	75.8% R.H.	*96.6% R.H.*
618	0.22	0.46
566	0.18	0.36
452	0.19	0.35
342	0.16	0.36
217	0.16	0.35
156	0.17	0.36
98	0.19	0.37
61	0.18	0.36

Table V. Effect of Wet Pressing on Expansion

Maximum pressure, p.s.i.	*Porosity, sec./100 ml. air*	*Per cent expansion at*	
		75.8% R.H.	*96.6% R.H.*
0	47	0.26	0.46
13	118	0.25	0.43
30	126	0.22	0.38
48	135	0.19	0.36
80	155	0.18	0.36

The foregoing results indicate that there is no significant difference in the expansion of sheets filled with clay and unfilled sheets, even though the filler increases the density of the sheets. With the addition of large amounts of clay, the voids of the sheet become filled and the dimensional changes would be expected to increase due to a more direct transmission of changes in fiber dimensions to the external sheet dimensions. Also, large additions of clay decrease fiber bonding and thus enable more interfiber movement.

Effect of High-Temperature Drying on Expansion

The literature is clear in indicating that fiber swelling decreases through the application of heat. Robertson and Mason (*34*) and Tarkow (*19*) agree in stating that fiber swelling is reduced following drying, and Weidner (*20*) found that swelling on moisture adsorption is decreased 50% by heating sulphite fibers at 103°C. for 2 hr.

To determine the effect of heat drying on expansion, wet handsheets were dried under various heat conditions which were used in other phases of this research to cure resins incorporated into the sheet. The results of the expansion tests are shown in Table VIII.

The test results included in Table VIII indicate that the application of heat to wet handsheets decreases the expansion of the dried sheets. Also, these data indicate that sheets dried at 105°C. and then subjected to higher temperatures have the same expansion as those treated only at 105°C., which is probably true only when the sheet is completely dried before being subjected to the higher temperatures.

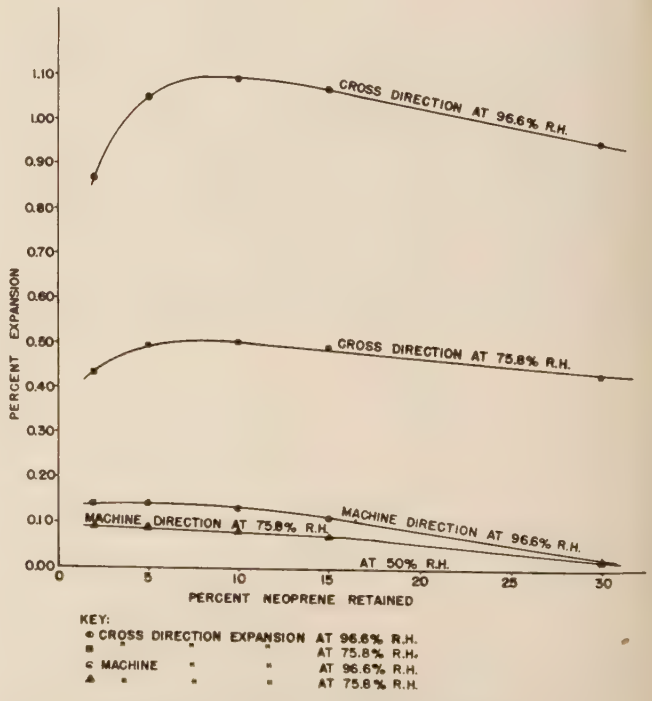

Fig. 7. Expansion versus per cent neoprene retained for machine-made papers

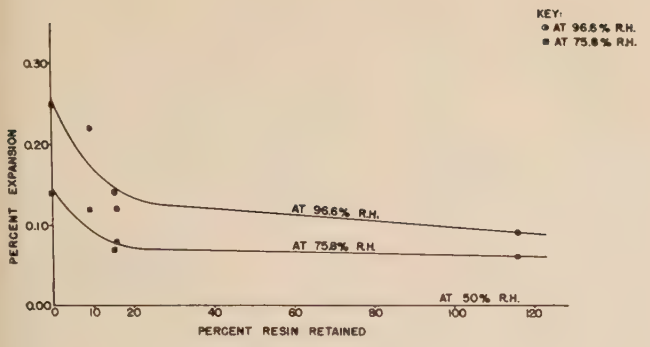

Fig. 8. Expansion versus per cent thiourea-formaldehyde resin retained

Next, to determine the relationship between expansion and the temperature applied to the sheet, the drying temperature was varied from 106 to 169°C. while the time of treatment was held constant at 20 min. The results are shown in Table IX.

The graphs of these data are straight line relationships as shown in Fig. 4. The results show that the expansion of the handsheets, with increasing humidity, decreases as the drying temperature increases. This result is due either to the decrease in the swelling of the fibers, an increase in fiber bonding, an increase in the strength of the bonding, or possibly a combination of two or more of these factors.

Effect of Pulp Type on Expansion

Information in the literature on the effect of pulp type on fiber swelling and fiber bonding is spotty and incomplete. Bixler (*27*) noted that alkaline pulps swell more than sulphite pulps, while Weidner (*20*) observed that overcooked and bleached sulphite pulps have larger fiber widths at all humidities than normally cooked, unbleached sulphite pulp. Forman (*35*) mentioned that the bonding characteristics of the fiber are influenced by the pulping process, degree of cooking, and bleaching.

Pulps of various types were broken up individually in a Waring Blendor and formed into handsheets. The Canadian Standard freeness varied from 300 plus or minus 100, but as previously shown, freeness within this range has no effect on expansion. The pulp types employed and the expansion results of the study are shown in Table X.

Graphical presentation of these data is made in Fig. 5.

A trend exhibited by these results is that the expansion of sulphite pulp increases as its purity increases. This additional expansion is probably due to increased fiber swelling rather than to decreased fiber bonding, since fiber bonding would be expected to increase with increased pulp purity.

The poplar and aspen, being hardwoods and having smaller fibers, show results surprisingly similar to the softwoods. The chemigroundwood pulp is a highly

Table VI. Effect of Wet Pressing on Expansion

Maximum pressure, p.s.i.	*Porosity, sec./100 ml. air*	*Per cent expansion at 75.8% R.H.*	*Per cent expansion at 96.6% R.H.*
2,322	1214	0.11	0.19
6,966	794	0.15	0.26
11,610	833	0.13	0.23
16,254	754	0.13	0.21
18,576	738	0.17	0.30

Table VII. Effect of Clay Filler on Expansion

Clay added, %	*Ash content, %*	*Per cent expansion at 75.8% R.H.*	*Per cent expansion at 96.6% R.H.*
0	0.80	0.18	0.36
5	2.02	0.17	0.33
10	8.08	0.18	0.36
15	11.76	0.17	0.35
20	19.63	0.20	0.40
25	19.75	0.20	0.42
30	26.80	0.18	0.38

lignified fiber and its high expansion values as compared to the bleached soda pulp may be due to fewer free hydroxyl groups participating in fiber bonding.

Effect of Sizing on Expansion

Size reduces the rate of water penetration into paper and it was thought that size may also reduce the adsorption of water vapor by paper. Pulp was treated with rosin and silicones as sizing agents in order to determine the effect of sizing on expansion.

Effect of the Beater Addition of Rosin on Expansion

Pulp for this series of runs was beaten to a freeness (C.S.) of 180 ± 15. After the predetermined quantities of rosin were thoroughly mixed with the pulp, 5% alum solution was added until the stock reached a pH of 4.3. The handsheets were dried at 105°C. for 20 min. Cobb size tests as well as expansion tests were run and the results are shown in Table XI.

Rosin obviously does not decrease expansion as humidity is increased. Actually, sheets treated with rosin show increased expansion. This result could be caused by the rosin molecules which may function to block off the hydroxyl groups of the fibers and decrease fiber bonding. The size apparently does not prevent adsorption of water vapor and thus with less fiber bonding expansion is greater.

Effect of the Beater Addition of Silicones on Expansion

Two silicones supplied by the Dow-Corning Chemical Co. were investigated, one being DC 1107, a silicone liquid, while the other was XR 129a, a silicone resin of 90% solids. The pulp was beaten to a freeness of 180 ± 15 and after the predetermined quantities of silicone were thoroughly mixed with the pulp, 5% alum solution was added until the stock reached a pH of 4.3. The results are shown in Table XII.

Each run in this series gave well-sized sheets, but as with rosin the expansion of the sized sheet increased

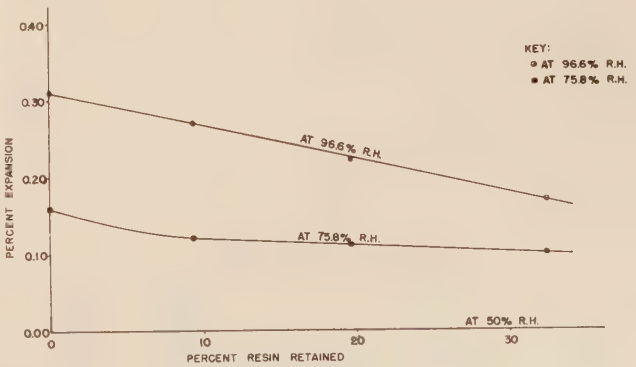

Fig. 9. Expansion versus per cent glyoxal-cellosize resin retained

Table VIII. Effect of Heat Drying on Expansion

Time, min.	Temperature, °C.	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.	Approximate decrease in expansion, %
10	175	0.13	0.27	25
20	105	0.17	0.33	10
20	150			
60	115	0.16	0.32	12
15	105	0.16	0.33	10
24 hr.	23	0.18	0.36	..

over that of the untreated sheet, indicating decreased fiber bonding.

Effect of the Addition of Neoprene on Expansion

Neoprene Latex type 735, a du Pont product, and a carefully prepared zinc oxide masterbatch dispersion for vulcanization, were added to pulp of 180 ± 15 freeness and pH 9, and precipitated with alum, in a procedure suggested by Abernathy, Walsh, Galloway, and Pockman (*36*). Sheets were formed and heat treated at 105°C. for 30 min. The expansion results are given in Table XIII.

The addition of amounts of neoprene above 20% resulted in decreasing the dimensional changes of handsheets, as shown in Fig. 6. As explained by Abernathy, Walsh, Galloway, and Pockman (*36*), neoprene particles stick to each other and to some extent to the fibers, but are nonpolar and therefore do not interfere with normal fiber-to-fiber bonding. Thus they reinforce the sheet by adding to the total number of bonds and also provide a certain number of water-resistant bonds.

Samples of machine-made neoprene papers furnished by the Claremont Paper Co. were tested for expansion in order to observe their behavior in comparison with handsheets. The papers varied in neoprene content from 2 to 30% and were of 75 lb. basis weight (25 × 40—500). The results are shown in Table XIV.

As indicated in the foregoing table of data and the graph of these results in Fig. 7, machine-made papers expand more in the cross direction than in the machine direction as is general knowledge. Also, it can be said that the action of neoprene on machine-made papers is very similar to that on handsheets because the graph of expansion versus neoprene is of the same general form for each method of manufacture.

Effect on Expansion of Impregnation with Thermosetting Resins

Four polar thermosetting resins were added to handsheets by impregnation to determine their effect on dimensional changes. The expansion results of the

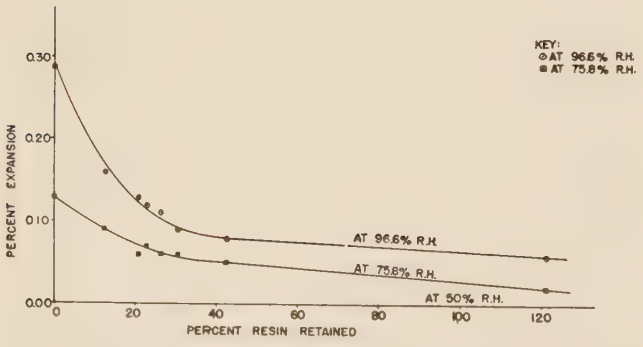

Fig. 10. Expansion versus per cent phenol-formaldehyde resin retained

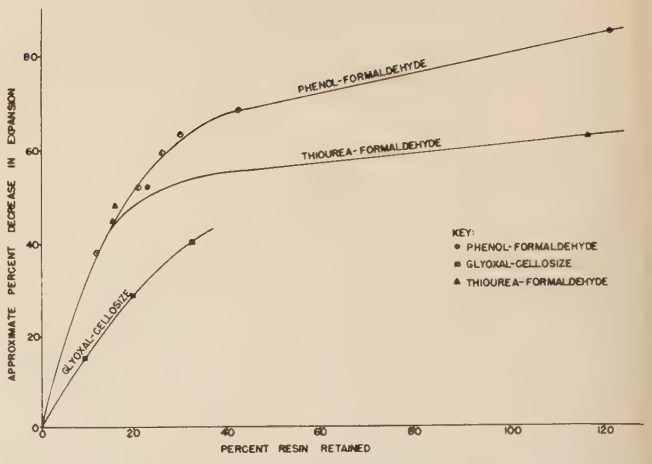

Fig. 11. Approximate decrease in expansion versus resin retained, for various resins

treated sheets were compared to those of standard sheets, which were processed in the same manner except they were dipped in water instead of resin solution. The resins used were those suggested by suppliers as probably possessing properties to give optimum results.

Effect of Thiourea-Formaldehyde Resin on Expansion

Thiourea-formaldehyde resin, supplied by Rohm and Haas at 60.5% solids, was diluted with water to the desired concentration and adjusted to a pH of 1.5 by the addition of phthalic acid, as directed by Stearn (*17*). The sheets were dipped in this solution and processed as described under Experimental Procedure, after which they were dried at 175°C. for 10 min. Beside the expansion tests, M.I.T. fold-tests at 0.5 kg. load were made to measure the brittleness of the resin-treated sheets. The results are as shown in Table XV.

The results show a definite decrease in expansion as the percentage of thiourea resin is increased, probably because of the bonding action of the polar thiourea resin molecules to the fibers. The graph of these data, as shown in Fig. 8, shows a sharp drop in expansion up to 20% resin, from where it levels off into a gradual decline. The handsheets at all resin contents measured, however, were brittle as shown by the fold test data in Table XV. The addition of 116% resin was unreasonable from an economic standpoint but was included in the investigation to determine the effect of this compound at high levels of application.

Effect of a Glyoxal-Cellosize Combination on Expansion

Gloxal and "cellosize" carboxyethyl cellulose, supplied by Carbide and Carbon Chemicals, were added by sheet impregnation in a ratio of 1:1 by weight. The sheets were processed as described under Experimental

Table IX. Effect of Drying Temperature on Expansion

Temperature, °C.	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.	Approximate per cent decrease in expansion
23	0.18	0.36	..
106	0.16	0.35	5
123	0.15	0.32	12
140	0.15	0.32	12
155	0.14	0.31	15
169	0.14	0.28	22

Table X. Effect of Pulp Type on Expansion

Pulp type	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
Unbleached sulphite (Spruce)	0.18	0.33
Bleached sulphite (Hemlock)	0.18	0.35
Alpha sulphite (Spruce)	0.23	0.43
Unbleached sulphate (Spruce)	0.18	0.36
Bleached soda (Poplar)	0.16	0.29
Chemigroundwood (Aspen)	0.20	0.42

Procedure and dried at 105°C. for 15 min. The results are presented in Table XVI.

The graph of the foregoing data, as shown in Fig. 9, is more of a straight line relationship than the graph of expansion versus per cent thiourea resin, as shown in Fig. 8. Thiourea shows a greater decrease in expansion for the amount of resin retained, but glyoxal-cellosize shows less brittleness. Glyoxal-cellosize, like

Table XI. Effect of Rosin Sizing on Expansion

Rosin added, %	Cobb test, g.	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
0	1.084	0.16	0.35
1	0.303	0.29	0.62
2	0.304	0.26	0.46
3	0.284	0.26	0.47
4	0.287	0.26	0.47
5	0.259	0.24	0.47

thiourea resin, is highly polar, and causes decreased expansion through polar bonding with the fibers.

Effect of Phenol-Formaldehyde Resin on Expansion

Resinox 468, a water-dilutable phenolic resin solution supplied by Monsanto Chemical Co., was the next thermosetting resin employed. This resin merely required dilution with water-alcohol solution before im-

Table XII. Effect of Silicone Sizing on Expansion

Silicone added	Heat treatment	Cobb test, g.	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
None	20 min. at 105°C.	0.871	0.17	0.33
1% DC 1107	20 min. at 150°C. 30 min. at 90°C. 10 min. at 150°C.	0.225	0.20	0.42
2% DC 1107	25 min. at 90°C. 10 min. at 150°C.	0.239	0.21	0.40
2% XR 129a	30 min. at 90°C. 10 min. at 150°C.	0.246	0.22	0.46
1.5% DC 1107 2% XR 129a	20 min. at 100°C. 20 min. at 150°C.	0.178	0.27	0.55

mersion of the handsheets. The sheets were cured by drying at 150°C. for 15 min. The results appear in Table XVII.

The graphs of the foregoing data as presented in Fig. 10, are very similar to the curve obtained by the plot of expansion versus per cent thiourea resin, as shown in Fig. 8. At low resin content, phenolic resins undergo about the same decrease in expansion as thiourea res-

Table XIII. Effect of Neoprene on Expansion

Neoprene added, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
0	0.16	0.35
5	0.20	0.36
10	0.18	0.32
15	0.20	0.38
20	0.17	0.30
25	0.11	0.25
30	0.12	0.24

Table XIV. Effect on Expansion of the Addition of Neoprene to Machine-Made Papers

Neoprene added, %	Cross direction; per cent expansion at 75.8% R.H.	Cross direction; per cent expansion at 96.6% R.H.	Machine direction; per cent expansion at 75.8% R.H.	Machine direction; per cent expansion at 96.6% R.H.
2	0.43	0.87	0.09	0.14
5	0.49	1.05	0.09	0.14
10	0.50	1.09	0.08	0.13
15	0.49	1.07	0.07	0.11
30	0.43	0.95	0.02	0.02

ins, for the same amount of resin retained, but the phenolic resins are more effective at the higher resin contents, as shown in Fig. 11. Phenolic treated sheets are also less brittle at the same resin content than sheets containing thiourea resins, as shown in Tables XV and XVII, but are darker in color.

Impregnation with Resinox 468 phenolic resin was the most successful of all the experiments conducted in

Table XV. Effect of Thiourea Resin on Expansion

Concentration of solution, %	Resin retained, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.	M.I.T. folds	Approximate expansion decrease, %
0	0.0	0.14	0.25	5234	..
5	9.1	0.12	0.22	2	12
10	15.1	0.07	0.14	1	45
15	15.9	0.08	0.12	1	48
30	116.0	0.06	0.09	0	62

this investigation in an attempt to decrease the dimensional changes of handsheets with changes in humidity.

Effect of Urea-Formaldehyde Resin on Expansion

Uformite 700, a cationic urea-formaldehyde resin supplied by the Rohm & Haas Co., was the final resin

Table XVI. Effect of Glyoxal-Cellosize on Expansion

Concentration of solution, %	Resin retained, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.	M.I.T. folds	Approximate expansion decrease, %
0	0.0	0.16	0.31	5721	0
5	9.3	0.12	0.27	36	15
10	19.7	0.11	0.22	1	29
15	32.5	0.10	0.17	0	40

employed in this investigation. Due to the cationic nature of the resin, alum was not necessary for precipitation. However, the resin solution was adjusted to a pH of 4.5 with HCl, prior to immersion of the handsheets, to facilitate an effective cure during the drying period of 20 min. at 105°C. The results are shown in Table XVIII.

Only at 5.7% resin retention were the dimensional changes decreased for the humidity increase from 50 to 75.8% R.H., but the dimensional changes were decreased in all of the runs for the humidity increase from

Table XVII. Effect of a Phenolic Resin on Expansion

Resin retained, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.	M.I.T. folds	Approximate expansion decrease, %
0.0	0.13	0.29	5091	..
12.3	0.09	0.16	926	38
20.8	0.06	0.13	12	52
22.9	0.07	0.12	1	52
26.2	0.06	0.11	3	59
30.4	0.06	0.09	2	63
42.4	0.05	0.08	0	68
121.0	0.02	0.06	0	84

Table XVIII. Effect of Uformite Resin on Expansion

Concentration of solution, %	Resin retained, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
0.0	0.0	0.16	0.31
	2.8	0.16	0.30
3.0	5.7	0.12	0.26
8.4	16.6	0.16	0.24
16.0	35.6	0.24	0.27

75.8 to 96.6% R.H. Urea-formaldehyde increases the hygroscopicity of the sheet, and thus more water is adsorbed during the initial humidity rise, but above 75.8% R.H. the moisture content prematurely approaches saturation and thus less expansion occurs. At 96.6% R.H. all of the urea resin-treated sample strips were extremely wet as if they had been dipped in water.

Except at high humidities, the use of Uformite 700 resin for dimensionally stabilizing paper is limited because of its high hygroscopicity. For papers used at high humidities it is a good stabilizer. The Uformite treated sheets showed no brittleness whatsoever.

Effect of Impregnation with Urea on Expansion

Fisher (*37*) showed that urea forms hydrogen bonds with reactive cellulosic hydroxyl groups, thereby satisfying these groups which would otherwise be involved in moisture adsorption. Urea also causes a mechanical separation of cellulosic chains or chain bundles and therefore reduces shrinkage on drying and maintains the cellulose in a state of dry swelling.

Crystalline urea was obtained from the E. I. du Pont de Nemours & Co. Sheets were immersed in solutions of the urea and processed in the same manner as with the thermosetting resins except that drying was performed at room temperature. The results are shown in Table XIX.

The data in this table prove that urea has a negative effect and increases the dimensional changes of handsheets with changes in humidity. The appearance of urea-treated sheets at 96.6% R.H., like urea-formaldehyde treated sheets, is very wet and indicates that an increase in hygroscopicity occurs upon the addition of urea. The urea also probably decreases fiber bonding and enhances relocation of the fibers. Therefore, as urea content is increased the fiber bonding is decreased by the combined effect of increased moisture content, due to increased hygroscopicity, and the direct action of the urea itself.

CONCLUSIONS

1. Handsheets made to different basis weights with the same pulp give the same expansion values.

2. Fiber size has no effect on the dimensional stability of handsheets except where it results in decreased fiber bonding, as with very coarse fibers, thus giving higher expansion values.

3. Freeness has no effect on the dimensional stability of handsheets except at high freeness values where fiber bonding is poor and expansion greater.

4. Fiber characteristics remaining the same, increased fiber-to-fiber bonding at higher densities, resulting from wet pressing, increases the dimensional stability of handsheets.

5. Beater addition of clay filler increases the density of the sheet but does not increase the dimensional stability.

6. The application of heat to wet handsheets decreases the expansion of the dried sheets. The expansion decreases in a straight line relationship with the temperature applied within the range investigated.

7. Dimensional changes in handsheets made with sulphite pulp increase as the purity of the pulp increases.

8. Handsheets made from hardwood pulps expand with increases in humidity to approximately the same degree as those made with softwood pulps.

9. Silicones give good sizing values when employed as beater sizing agents but neither the amount nor rate of dimensional expansion decreases with increases in the degree of silicone sizing. Beater sizing with rosin also does not decrease dimensional changes with changes in humidity.

10. Neoprene-treated handsheets show decreases in expansion as the addition of neoprene is increased above 20%.

11. Phenol-formaldehyde resin, thiourea-formaldehyde resin, and glyoxal-cellosize combination all give decreased expansion with increased humidity, as the resin content of handsheets is increased by impregnation with these compounds. Phenol-formaldehyde shows the greatest effect in lowering expansion for equal amounts of resin retained, while glyoxal-cellosize shows the least beneficial effect.

12. Cationic urea-formaldehyde resin increases the hygroscopicity of the sheet to the extent that any influence the resin may have in decreasing dimensional changes is nullified by the increased moisture adsorption.

13. Urea, when applied by impregnation, has a negative effect and increases the dimensional changes of handsheets with changes in humidity.

Table XIX. Effect of Urea on Expansion

Concentration of solution, %	Urea retained, %	Per cent expansion at 75.8% R.H.	Per cent expansion at 96.6% R.H.
0.0	0.0	0.16	0.35
12.3	17.8	0.23	0.48
20.0	36.0	0.28	0.53
40.0	85.5	0.24	0.65

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The Va-Purge Process in Chemical Pulping

J. S. HART

A requirement for efficient pulping is uniform and thorough penetration of the raw material defined as the forced movement of liquid (forced penetration) together with the diffusion of solutes (natural penetration). Included air impedes penetration. The Va-Purge process is a pretreatment technique for the removal of both surrounding and included air by means of a steam purging mechanism involving pressure cycles. Subsequent penetration is very rapid and efficient to the extent that the surrounding liquid may be partially or wholly withdrawn. The pulping may then take place in low liquor-to-wood ratios down to the "vapor phase." Applications to batch systems and continuous equipment are described.

One of the underlying requirements in the efficient chemical pulping of wood or of any other lignocellulosic material is the uniform and thorough penetration of cooking liquor into the wood. The word "penetration," in general, is used to designate not only the mass movement of liquids, solutions, and gases or vapors through the bulk of wood as such, but also the movement of solutes through wood already impregnated with solvent. The forces coming into play in these two kinds of movement are different in nature. The mass movement is governed by a differential mechanical pressure such as occurs when water is forced through a wooden disk by a hydraulic differential; the second is caused by an osmotic pressure and is exemplified by a chip completely filled with water immersed in, for example, a sodium hydroxide solution, the sodium hydroxide penetrating as molecules into the bulk of the wood as long as a concentration difference exists. This latter phenomenon has been called, for convenience, "natural penetration" as opposed to the former which is called "forced penetration."

The chemical pulping of wood consists of the separation of cellulose fibers from other wood constituents. This separation is dependent on changing the lignin chemically so that the lignin can be dissolved out, or, at least, be made to loosen its encrusting embrace on the cellulose fibers. The liquor containing the chemicals which are able to do this must reach the lignin in the wood. In conventional chemical pulping operations, the first stage of the impregnation of wood chips is, therefore, forced penetration, the pressure in the digester forcing the cooking liquor into the pores through the surface of each chip. Subsequently, with cooking, a change in concentration of this liquor in the chip takes place and natural penetration, or diffusion, of additional chemicals into the wood material, with counter outward diffusion of lignosulphonic acid and other cooking products, occurs.

The above is a very simplified explanation of the penetration of cooking liquors into wood substance, and there are many factors which influence the rate and efficiency of this penetration. Given a sufficiently long time and an appropriate temperature, the maximum result to be obtained by forced penetration and its effects on natural penetration *could* be achieved by what we choose to call normal penetration (i.e., the mere submergence of wood chips in a solution of pulping chemicals). Such a chip, once fully submerged, is subjected to a hydrostatic forced penetration the magnitude of which is proportional to the weight of the column of liquid above the spot where penetration is taking place. The air that is in the chip impedes this forced penetration and must be removed before the penetration will be complete. A small amount of air can produce an effect on the rate of penetration which is quite out of proportion to the very small volume of air that is entrapped. When a chip is surrounded by the cooking solution, the only way for this air to get out of the chip is for it to be dissolved in the cooking liquor. Increased temperature and pressure are, of course, an aid in this solution.

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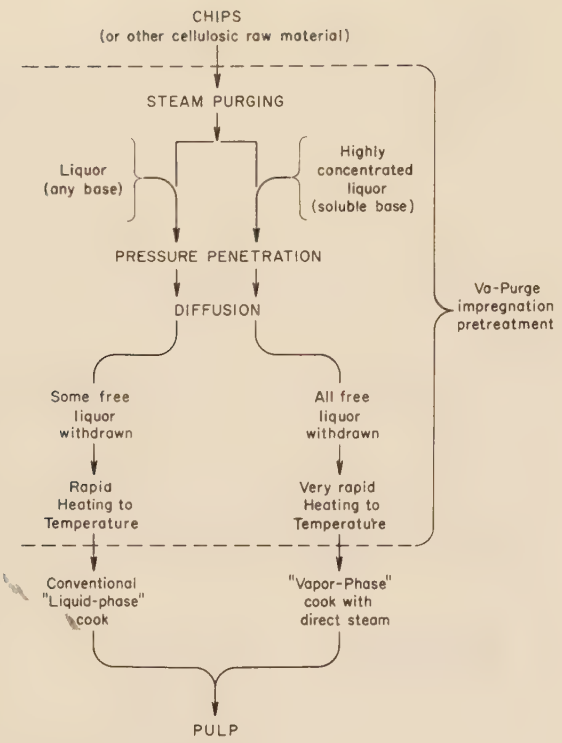

Fig. 1. Va-purge impregnation pretreatment and subsequent cooking techniques

The Va-Purge process, on which the Institute holds both United States and Canadian patents, derives its name from its use of steam to purge or remove noncondensible gases (i.e., air) from wood or other vegetable tissue. It is essentially a *pretreatment* process. That there are unexpected benefits from this pretreatment other than the mere removal of air is apparent from the fact that a most efficient diffusion of chemical into the treated tissue takes place when the steam-purged material is submerged in cooking liquor. Recent experiments at the Institute have shown that the rate of diffusion of an electrolyte through a chip can be doubled by purging. Also, the rate of diffusion in a purged chip is much greater than in one that has only been steamed without purging.

In addition, the steam ejected from the purge, when condensed, is found to contain a number of substances which could and may hinder the penetration of the wood of certain species, notably jack pine heartwood.

It is not intended in this paper to compare the Va-Purge process with other pretreatment processes, nor to discuss its possible benefits or economic advantages but merely to explain the details of the technique used in the process. Numerous pretreatment techniques have been described in the technical and patent literature; but at the time when Va-Purge was first introduced to the Canadian industry, none had been reduced to practice generally in Canadian or other mills.

DESCRIPTION OF PROCESS

The Va-Purge impregnation pretreatment process as a part of the pulping process can best be described as in the following diagram (Fig. 1). The steps are as follows:

The Purging Cycle

Purging is accomplished by the use of steam. The purging cycle is carried out in a pressure vessel into which the chips have already been introduced. The purge consists of a rapid build-up of pressure to a predetermined level through the introduction of steam to the pressure vessel which may or may not be maintained for a period at this top pressure as found desirable to bring the charge uniformly to a temperature equivalent to the top pressure, followed by a rapid release of pressure to a predetermined lower level. The purging cycle may consist of any number of separate purges, each one removing a fraction of the air inside the vessel including that within the chips, which fraction is determined chiefly by the magnitude of the rise and fall of the pressure.

Liquor Charging

When the purging cycle has been completed, liquor of a desired composition is run into the digester without permitting the reintroduction of air. It may be necessary to carry out this step under pressure, if the final pressure of the purging cycle be superatmospheric.

Penetration Cycle

When the digester has been filled with liquor to capacity, or at least to submerge the total chip charge, a predetermined pressure is applied and maintained adding further liquor as necessary to keep the liquid level above the chips. This constitutes the forced penetration phase of the penetration cycle. For more efficient distribution of chemical throughout the wood substance, the penetration cycle is completed by maintaining the charge in contact with liquor, which causes a diffusion of chemical from the liquid into the chips.

This is a phase of natural penetration which tends to establish an equilibrium concentration of chemical in all of the liquid within the vessel.

Since natural penetration is a diffusion process, its rate will be affected by temperature, and such phenomena as adsorption will have their impact on the final equilibrium. At temperatures above and near 80°C. considerable natural penetration is complete in about 10 min., although an appreciable further amount will take place when the interval is extended from 10 to 40 min. The length of the natural penetration step is extended from 10 to 40 min. The length of the natural penetration step is a matter of expediency and of the efficiency desired.

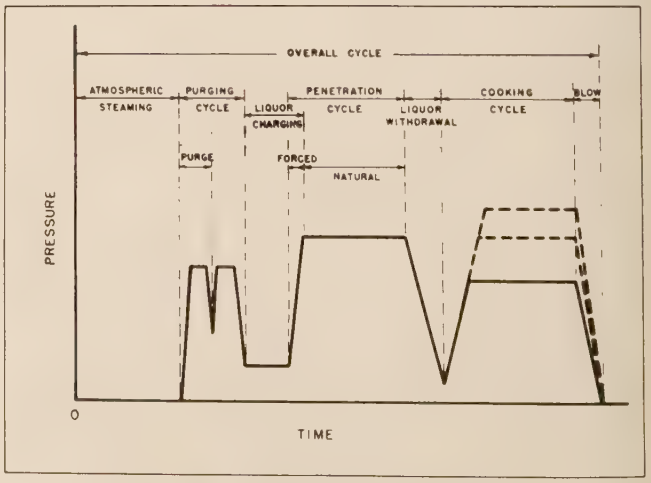

Fig. 2. Diagram of cycle

ADAPTATION TO CONVENTIONAL EQUIPMENT

Now to consider briefly the adaptation of this process to conventional equipment. With Va-Purge as with many other new developments, there probably is no mill so designed as to take maximum advantage of the opportunities offered by the process. Each mill is a separate case. One has extra digester capacity, so that the shorter time cycle would not be too meaningful. Another is short on digesters, but has inadequate steam plant or insufficient pulp handling capacity, etc. Very few mills have lines and pumps intended for the very rapid introduction and withdrawal of steam and liquor which is essential to the best results in using this impregnation method and the improved cooking practice it makes possible. Consequently, the application of this new method with existing equipment must generally be a compromise in which the advantages to be gained are balanced against the costs of making the alterations to adapt the total mill setup. Nevertheless, by making some modifications (generally not too costly) and experimenting persistently and judiciously, combinations and compromises can be found for existing mill conditions that will mean substantial returns.

The steps in the process are shown again diagrammatically in Fig. 2.

The application of this technique to a small laboratory-type digester is relatively simple. The steaming to a pressure and the subsequent relieving can be carried out very rapidly, and even four purges can be accomplished in less than 12 min. The other operations can likewise be carried out very rapidly.

In translating to the mill scale with most conventional equipment in present-day mills, however, much of the time saving may be lost through inability to carry out the several successive operations with anything approaching the speed of the laboratory scale because of the limitations imposed by existing pipes, pumps, fittings and, perhaps, steam supply. Yet this does not need to be the case since, with proper initial design, or with adequate alterations, both rapid purging and steaming are possible. In the majority of mill trials to date, it has not been possible to make these changes. Therefore, the trials did not always achieve the full benefits attainable through the use of the Va-Purge impregnation pretreatment process.

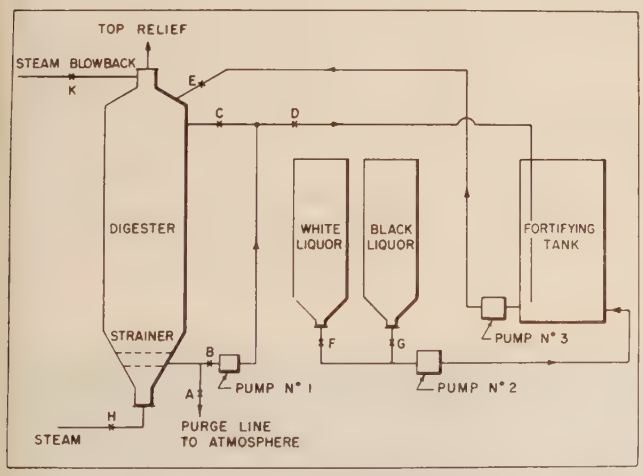

Fig. 3. Diagrammatic arrangement for use of Va-Purge in kraft operation

1—Steam pressure is built up for purging through steam valve H. Then valve H is closed and valve A is opened. This entire operation may be repeated for a second purge, if desired. 2—The digester is then pumped with a mixture of black and white liquor, previously made up in the fortifying tank. Pump no. 3 is not shut down until at least 3 min. after liquor has appeared at the head relief. Valve E will always be closed before pump no. 3 is shut down. 3—Steam valve K is now opened to provide pressure for the impregnation step. 4—During impregnation the black and white liquor charge for the next cook is pumped to the fortifying tank from the liquor storage or measuring tanks by means of pump no. 2. 5—At the end of the impregnation, valve K is closed and valve D is opened. At the same time, pump no. 1 is started and liquor is withdrawn to the fortifying tank where it is mixed with that which is already there, and the liquor is then ready for the next cook.

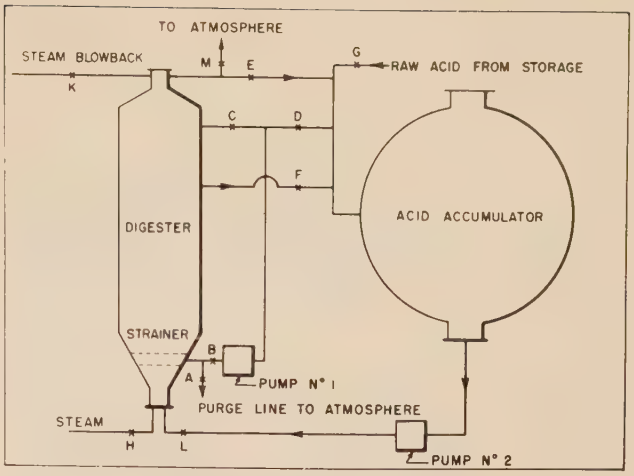

Fig. 4. Diagrammatic arrangement for use of Va-Purge in sulphite operation

1—Steam pressure is built up for purging through steam valve H. Then valve H is closed and valve A is opened. This entire operation may be repeated for a second purge, if desired. 2—The digester is then pumped with the cooking acid from the accumulator by means of filling pump no. 2 through valve L. During pumping the circulating system (pump no. 1 through valve C) may be operated. If it is not, then any built-up steam pressure can be relieved through valve M. Shortly before pumping is completed, valve M is closed and valve E is opened. The filling pump (pump no. 2) is not shut down until at least 3 min. after liquor is picked up at the head relief. Valve L will always be closed before pump no. 2 is shut down. 3—Steam valve K is now opened to provide pressure for the impregnation step. 4—After impregnation valve K is closed and cooking, either direct or indirect, is started. At the same time as pressure is built up, the side relief is removed through valve F. 5—If a soluble base is being used and a lower acid-to-wood ratio than with calcium base is required, then excess acid may be removed through pump no. 1 and valve D to the accumulator before starting the cook.

Before dealing with the adaptation of Va-Purge to a specific pulping process, the author would like to direct attention to some general practices common to all standard commercial pulping methods.

The first has to do with steaming of the filled digester. This operation may well be combined with filling the digester. That has the double advantage of aiding in the packing and in saving time. With adequate steam flow, and with proper distribution of steam such as can be obtained by using nozzles, the removal of air surrounding the wood material (and probably also some of that within it) should be essentially completed by the time the digester is full. Thus, the removal of a good deal of the air in the digester need not add to the length of the cycle.

In the second step, that of raising the pressure to a level between approximately 10 and 50 p.s.i., adequate steam flow and proper steam distribution will have a great influence on the efficiency. In the laboratory, as mentioned above, the upper pressure can be attained in about 1 min., whereas 20 min. would be exceptionally

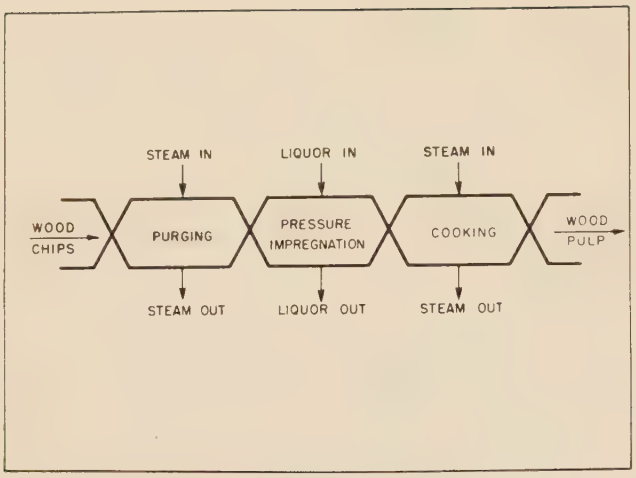

Fig. 5. Schematic diagram of continuous pulping with Va-Purge

fast time for conventional equipments that have not been modified. Proper initial design or modification can cut this time in half.

The rapid relief in the purging cycle cannot usually be achieved in practice without, in most cases, a major alteration to conventional design. The ordinary relief lines are quite inadequate for relieving the steam pressure rapidly; but, where liquor circulating systems have been installed, they can be tapped and used for relief. Even with the large strainer area which is thus made available, the relief may be so relatively slow that additional strainer capacity might be added with advantage, in many instances.

In the penetration cycle, the pressure may be provided by the liquor filling pump. If not, a steam pressure can be applied to the top of the liquor by means of the blowback line connected to the top strainer. It has been found that at pressure of a least 20 p.s.i. is required to assure rapid penetration. Many filling pumps now installed will maintain pressure in excess of this. There is experimental evidence that forced penetration is actually completed in 2 to 3 min. Yet, a longer period is necessary to allow for the natural penetration or diffusion. With most full scale equipment it is not possible to fill the digesters very rapidly, nor is it possible to bring them to temperature in very short time. Hence, there is a considerable time available for natural penetration or diffusion in addition to that provided in the impregnation period. As a result, the relatively long temperature rise necessary with large equipment because of the limitations of the equipment, allows nonuniformity of the penetration to be evened out. For this reason, variations from the Va-Purge technique as worked out in the laboratory are sometimes made in adapting it to conventional equipment.

The withdrawal of excess liquor will be dealt with in more detail with specific reference to the alkaline and acid processes. At this point, it should be noted that more liquor can be pumped into a digester whose contents have been previously pretreated by the Va-Purge process. This extra liquor is that which is taken up by the raw material to be cooked. It is equivalent roughly, to the oven-dry weight of that material. If this liquor has the same concentration as that used in the normal mill practice, then a portion should be withdrawn after impregnation in order that the charge will remain as it would be without Va-Purge. Where there is a liquor circulating system, and particularly if the strainer is situated in a lower part of the digester, the withdrawal of this excess liquor presents no great problem. If that situation does not exist, then a strainer must be installed if full advantage is to be taken of the pretreatment process.

The concept of withdrawing and removing some of the excess liquor after penetration leads, logically, to increasing the initial concentration in order to reduce the final volume below that normally used. Such a reduction of liquor with its high specific heat requirement in relation to that for the wood or other material allows the contents to be raised in temperature more rapidly than is possible with the normal volume of liquor left in the digester. The result is a marked reduction in the over-all cooking time.

Carrying this technique a step further, it is possible to remove all the free liquor in the digester after penetration. The cooking can then be carried out with direct steam in the so-called "vapor phase," normally under pressure. This is not a new procedure, but it is made practical for the first time by the full penetration achieved through the Va-Purge process. Under certain conditions vapor-phase cooking has marked advantages; but it may not be applicable to all grades of pulp.

THE ALKALINE PROCESS

A diagrammatic sketch showing how Va-Purge may be incorporated into alkaline cooking is shown in Fig. 3.

It is assumed that there is a liquor circulating system with the strainer in the bottom cone. After purging the liquor is pumped to the digester from what is termed a mixing and fortifying tank. This is a novel feature, not commonly used in alkaline mills, which allows the black and white liquors to be mixed thoroughly before pumping them to the digester. Then following impregnation, the excess is withdrawn to this tank where it can be fortified in preparation for the next cook. However, should advantage of the full Va-Purge process with lower liquor-to-wood ratios down to the vapor phase, not be required, then this tank could be elimi-

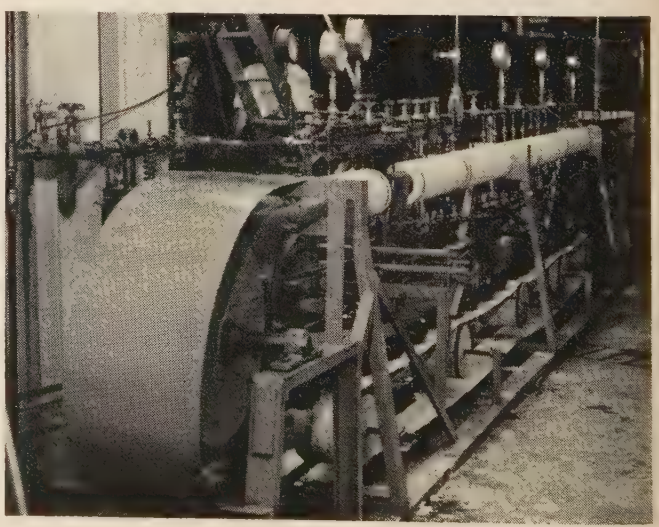

Fig. 6

nated. In that case, after purging, the normal volume of black and white liquor could be pumped simultaneously to the digester and the pressure impregnation step could be eliminated.

With the full process the liquor may be more concentrated—in other words, may have less black liquor in the make-up. The liquor-to-wood ratio remaining for the cook can, therefore, be reduced below that normally used. A limiting factor, present in many mills, may be, however, the concentration of the white liquor available for fortifying the liquor withdrawn.

During impregnation there is a drop in the concentration of the liquor because of dilution from the moisture contained in the chips and also because of some adsorption of the chemical on the wood. With the liquor-to-wood ratio possible with conventional digesters during impregnation, the final concentration is approximately 75% of the initial concentration. Also the chips will take up a volume of liquor approximately equivalent to their own oven-dry weight. Therefore, to keep the system in balance, the fortifying liquor must contain sufficient chemical to regain the initial concentration. Moreover, this chemical must be contained in a volume not larger than that left in the digester. With white liquor from the causticizing plant having a concentration of approximately $6^1/_2$ lb. of active alkali per cu. ft., expressed as Na_2O, the ratio by weight of liquor-to-wood left in the digester in order to meet this condition cannot be much lower than about 1.8 to 1. Thus, to gain the advantages of vapor phase cooking in alkaline pulping, it is necessary to have a more concentrated chemical make-up, achieved by using strong caustic and perhaps some elemental sulphur, or by some degree of evaporation.

In addition to the saving of time and steam made possible by lower liquor-to-wood ratios, the very thorough penetration brought about by the Va-Purge process permits very rapid temperature rises and thereby appreciably reduced cycles even in liquid phase cooking. The extra time required for the purging operations, including that when pumping is done separately from chip filling, can be more than made up in the reduced period of steaming to cooking temperatures.

THE SULPHITE PROCESS

The same general considerations hold for the sulphite process with the qualification, however, that the sulphite process is usually associated at the present time with the use of calcium bisulphite and therefore, the degree of concentration of the cooking acid is limited. Hence, vapor phase cooking is not practical with calcium bisulphite. Figure 4 is a diagrammatic plan of the conventional hot acid system with Va-Purge.

The filling, presteaming, and purging operations are similar to those already described. These are followed by pumping; but, in this case, the cooking liquor or acid contains a volatile gas, i.e., SO_2. As the acid comes in contact with the warmer chips, some of the SO_2 is liberated. However, this does not remain long in gaseous form since wood, especially steamed wood, has a high affinity for such SO_2. Consequently, there is no material build-up of pressure during the pumping operations, provided the steam in the digester is condensed.

In commercial trials it has been possible to fill the digester, for all practical purposes completely, during pumping with the head relief closed, while at the same time operating the circulating system to condense the steam.

With a calcium-base acid little reduction can be made in the acid-to-wood ratio. However, because of the complete penetration, the side relief can be removed immediately following the impregnation period and coincidental with the beginning of steaming. As a result, the side relief is generally more concentrated than in normal practice without Va-Purge.

The advantages to be gained through the use of Va-Purge with a *soluble-base* acid are much more striking since a more concentrated acid may then be used, and that makes possible progressively lower acid-to-wood ratios and, finally, vapor phase cooking.

In commercial practice with a calcium base, once complete penetration has been achieved through the use of Va-Purge, rapid temperature rises are feasible. To do this will, however, require adequate pumps and lines and such adequate distribution of the steam as can be accomplished with nozzles. In most of the mill scale efforts to apply Va-Purge to sulphite pulping thus far, such modifications of equipment have not been provided for a variety of reasons. Consequently, the procedure adopted has been a compromise between the best ultimate practice and something which may be considerably better than no pretreatment at all.

The results from commercial trials using a calcium base have resulted in more rapid temperature rises. Consequently, for any given over-all time, lower maximum temperatures can be used. This has resulted in a somewhat higher yield of pulp with attendant advantages in quality. Also it has been noted that pulps made with the Va-Purge pretreatment process can have a slightly higher lignin content with no increase in the amount of chlorine used in bleaching. We attribute this for the most part to the uniformity of the unbleached pulp.

With *soluble bases* commercial sulphite cooks have been made in the vapor phase which have a very high degree of uniformity of product, particularly in the high yield—that is, in a range of about 75%.

CONCLUSION

In conclusion, the author would like to repeat that the Va-Purge technique is a practical method for accomplishing rapid and complete penetration. Once this has been achieved, it is possible to cook with low liquor-to-wood ratios down to the "vapor phase." This can result in very rapid cooking time. And that leads logically to the conception of rapid continuous pulping. This could be represented diagrammatically in the schematic drawing in Fig. 5.

In order to test this technique, the Institute has built a continuous pulper shown in Fig. 6. The pulper is not intended to be a model that could be enlarged efficiently to a commercial scale. Nevertheless, it does embody the principles outlined and it has operated not once but many times and produced slush grades of kraft pulp from spruce chips in 45 min. from the entry of the raw chips at one end of the pipe to the discharge at the opposite end. In this operation, the time at reacting temperature was 30 min.

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Techniques for the Determination of Pulp Constituents by Quantitative Paper Chromatography

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Quantitative chromatographic techniques are generally sensitive, but suffer from being expensive in man-power requirements. In this paper, methods are described for reducing the cost of such work. The various steps, including hydrolysis, neutralization, evaporation, separation, elution, and final sugar determination have all been studied to minimize time requirements and to determine the errors contributed by each step. The usefulness and present limitations of the technique are described. A comparison has been made between the pentosan content of pulps determined by the Technical Association of the Pulp and Paper Industry's method and the values obtained by chromatographic analysis. At high pentosan content, agreement is satisfactory. At low pentosan content, the TAPPI method is shown to have high inherent errors due to the fact that the residual unhydrolyzed cellulose contains relatively large amounts of pentosan. The error due to this cause can be eliminated by total hydrolysis of the pulp, followed by an appropriate pentose analysis.

THE value of paper chromatography in the study of the composition of wood and pulp has been well established (*12, 24, 28, 29*). The group at the Central Laboratory in Finland has been especially active in this field (*7, 8, 9, 19, 20, 26, 27*).

Laboratory manuals are now available that cover the field of applied paper chromatography (*1, 2, 3*). It is the purpose of this report to describe work that has been done at the Forest Products Laboratory to increase the speed and accuracy of certain steps, evaluate experimental deviations, establish correction factors, and apply the techniques to the determination of the carbohydrate constituents of purified pulps. Particular attention has been paid to the determination of xylan and to the evaluation of difficulties in the TAPPI pentosan determination.

The quantitative paper chromatography of pulps requires the following steps: (1) total hydrolysis, (2) neutralization, (3) evaporation, (4) chromatographic separation, (5) elution of sugars from paper, and (6) quantitative determination of separated sugars. If sugars are determined by direct photometric measurement, step 5 may be eliminated.

APPARATUS FOR PAPER CHROMATOGRAPHY OF PULPS

The regular application of paper chromatography to routine research problems requires accessory equipment that permits accurate work with a minimum of time and effort. The equipment described in this report includes adaptations or innovations found useful at the Laboratory. The emphasis on convenience results from the fact that the many variables in pulping lead naturally to a need for many analyses.

Evaporator for Hydrolyzate

Pulp hydrolyzates are necessarily very dilute. They must be concentrated to a small volume without decomposition and preferably in a minimum of time.

A convenient still for this purpose is shown in Fig. 1. It consists of a conventional vacuum evaporator adapted to the needs of chromatographic work by using capillary tubing entering through the jacket of the heater to minimize holdup. As it is necessary to have an efficient condenser to permit distillation at low temperature, the simple condenser shown was made from streamline copper pipe.

A critical feature of the evaporator design is to provide a smooth tangential entry of the line from the heater to the liquid reservoir. If the evaporation is started with cooled liquid and if a slow stream of air is admitted during the evaporation, operation is almost foolproof. The distillation is carried out below room temperature at a rate of 10 ml. per min., using water at 13°C. for the aspirator and condenser.

With the multiple unit shown in Fig. 2, one operator can evaporate 50 samples per day from 200 to 3 ml. Where it is sufficient to know the ratio of constituents in a pulp, quantitative removal from the evaporator is not necessary. A high recovery of the concentrate can be obtained by draining through the stopcock. To effect quantitative removal of the concentrated sugars, the evaporator is lifted from the condenser and fitted to a flask containing rapidly boiling dilute alcohol. The vapors condensing on the cold inside surfaces wash out the sugars with a minimum of dilution.

The resulting solutions can be further concentrated by connecting the containers (vials or 25-ml. Erlenmeyer flasks) to a manifold as shown in Fig. 3. The samples are chilled and then connected to an aspirator. If no outside heat is supplied, vacuum evaporation will go on below room temperature without ebullition. A dozen such 5 to 10-ml. samples attached to a manifold can be evaporated overnight, with a single small aspirator providing the vacuum.

Decomposition Resulting from Evaporation. With the equipment described, 100 ml. of 0.15% xylose solution adjusted to pH 4 with acetic acid was evaporated to a volume of 1.5 ml. This was then rediluted to 150 ml. and re-evaporated five times. Even these exaggerated conditions using the very sensitive sugar, xylose, caused the loss of less than 1% in reducing power. It is obvious that in ordinary use the evaporator causes no significant decomposition.

Application of Hydrolyzate to Paper

Most of the chromatographic work at the Forest

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Products Laboratory is done using Whatman no. 1 paper in 18 by 24-in. sheets, with the long dimension being vertical. According to common practice, the starting line is drawn with a ruler notched at 5-ml. intervals. At each indicated interval, hydrolyzate is applied, usually in a volume of 2 lambdas. Application is made very conveniently with a 0.1-ml. mercury displacement microburet (*6*) modified as shown in Fig. 4. In making the adaptation of the buret shown, it is well to reduce the inside diameter of the vertical capillary to approximately 0.1 ml.

During the spotting, the paper is supported over parallel rods as shown. One operator works the buret while another moves the paper. Two fillings of the buret provide spots of 2 lambdas at 5-ml. intervals across the 18-in. sheet. The equipment provides more than the necessary precision.

The technique of multiple spotting is equivalent to applying a uniform streak of sample to the paper. It has the advantage of loading the paper to its maximum capacity and minimizing the uncertainties due to the paper blank.

After irrigation is completed, a template and a sharp knife are used to cut four evenly spaced 75-mm. strips in the long direction of the sheet. This permits quadruplicate sugar analyses. Indicator strips are left on each side of each 75-mm. strip taken for analysis. The sugars are located in the usual way using aniline phthalate reagent. The spraying operation is carried out on a rack that provides space for all the paper from one cabinet load. To develop the color, the entire rack is heated in a large oven with forced-air circulation.

Cabinets for Chromatographic Separation

Cabinets available commercially are suitable for handling eight 18 by 24-in. sheets. If cabinets are built, a number of additional useful features can be incorporated.

With butanol and pyridine as irrigating solvents, the vapors are very objectionable. This difficulty was minimized at the Laboratory by fitting each cabinet with a 2-in. nozzle to which could be coupled a flexible hose from a hand vacuum cleaner. The exhaust was led to a fume hood. This arrangement is expecially useful during the unloading operation.

In order to speed the attainment of vapor equilibrium prior to starting a chromatogram, a 2-in. fan blade was placed in each cabinet and driven from the outside by a 15-w. motor. A horizontal baffle was placed between the fan and the bottom of the sheets.

To avoid upsetting vapor equilibrium, it is convenient to add irrigating solvent to the troughs without opening the cabinet cover. This can be done by using a glass plate cover under the insulated cover. The plate has stoppered holes in the correct location for filling the troughs.

Chromatographic jars and cabinets should be protected against temperature differentials and against changing temperatures. With the cabinets located in a small room, a simple arrangement can keep the room thermostated at slightly above normal room temperatures. In work at the Forest Products Laboratory, a temperature of 30°C. is maintained.

By keeping variables under control, chromatograms can be consistently run in such a way as to give maximum resolution. Failure of control may cause insufficient separation or may cause the xylose, the most mobile of the sugars in pulp hydrolyzates, to run off the end of the sheet.

Elution Pipets and Elution Rack

If sugars are to be determined in small quantities by a chemical method, they must be separated from the 75 by 50-mm. tabs of paper on which they have been located. The method in use at the Forest Products Laboratory permits this to be done quantitatively with little solvent and little manipulation. The technique combines the suggestions of Dimler (*4*) and Hawthorne (*11*).

The tabs cut from air-dried chromatograms are hung, with the 75-mm. dimension vertical, from 2-in.-square slide glasses (*4*). Capillary pipets, Fig. 5, touching the bottom edge of the paper pick up the eluate. The details of this operation are shown in Fig. 6. In order to avoid evaporation of water from the papers, the assembly is enclosed in a glass-covered humidified box.

The elution is started by filling the trough with water. Water rises by capillarity between the plates, flows down the paper and into the pipets. When a pipet is filled, capillary forces prevent flow through the pipet, and surplus water flows past the tip. The volume provided by the $^3/_8$-ml. pipet is more than adequate to remove all of the sugar from the paper. The last water to enter is sugar free. In discharging the pipet into a test tube for analysis, the first liquid to enter is drained out, followed finally by water.

The sugar contained in the pipet can be applied to a second paper for rechromatographing with another solvent. Thus, with the butanol-pyridine system, mannose and arabinose are not separated. These two sugars can be eluted into a pipet, applied in a streak on a second sheet of paper, and the mixture resolved using ethyl acetate, acetic acid, and water. A strong jet of unheated air directed under the sheet causes the respotted material to dry so rapidly that the operation is not time consuming.

A test was made of the effectiveness of capillary elution pipets. Sugar solutions of various concentrations were spread evenly over 50 by 75-mm. tabs of filter paper and then dried. The tabs were eluted as described, and, after removal of the first pipet containing in this case 0.25 ml. of eluate, a second portion was collected equal in volume to the first. The results are given in Table I.

The important value to be read from this table is the sugar recovered in the second pipet. Within the limits of accuracy of the method, recovery is quantitative with 0.250 ml. of eluate. The above results were obtained without tapering the bottom edge of the tab. In practice, most of the sugar on a tab is in the center, and a small amount of tapering can be done with no significant loss of sugar if the paper removed is confined to the outside quarters of the sheet.

Table I. Recovery of Glucose from Paper Using Elution Pipets

Glucose applied, gammas	*Glucose recovered in first 0.250 ml., gammas*	*Glucose recovered in second 0.250 ml., gamma*
600	596	1.3
2000	1960	5.7
2000	1960	2.0

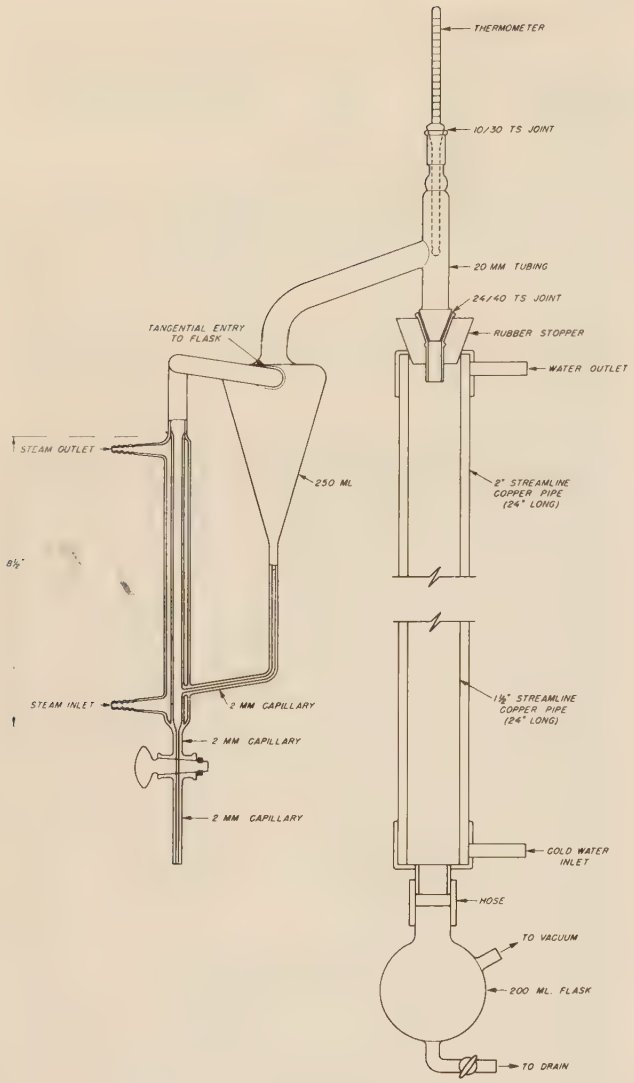

Fig. 1. Cross section of evaporator unit for concentrating sugar solutions

While less than a quarter of a milliliter suffices to elute a 50 by 75-mm. tab of paper, it has been common practice at the Laboratory to increase this by 50% to $^3/_8$ ml., allowing a generous safety factor.

PROCEDURES

The Total Hydrolysis of Cellulose

The total hydrolysis of cellulose requires primary hydrolysis in strong mineral acid followed by secondary hydrolysis in dilute acid. Decomposition of sugar cannot be avoided, so it is necessary to standardize the process and establish correction factors for the material that is lost.

A widely used procedure for total hydrolysis is that of Hägglund and co-workers (*10*). This method requires 4 hr. of primary hydrolysis with 72% sulphuric acid at room temperature followed by intermediate dilution and standing for 6 hr., and finally a 6-hr. secondary hydrolysis.

The hydrolysis in use at the Forest Products Laboratory requires 1 hr. of primary hydrolysis at 30°C. followed immediately by 1 hr. of secondary hydrolysis in a laboratory autoclave (sterilizer). The more rapid procedure is possible because primary hydrolysis with the higher temperature and shorter time is adequate, and the decomposition which it causes is much less than the decomposition caused by the secondary hydrolysis.

The amount of decomposition resulting from primary hydrolysis was established by subjecting glucose, galactose, mannose, arabinose, and xylose to simulated total hydrolysis, both with and without primary hydrolysis. The reactions were carried out for the normal reaction time. In other experiments, the times were extended to exaggerate the effects. The results showed clearly that for all sugars under normal and exaggerated conditions, there is at least four times as much decomposition caused by secondary hydrolysis as is caused by primary hydrolysis. The secondary hydrolysis cannot be reduced significantly, and there is no important benefit to be gained by minor changes in the primary hydrolysis.

The function of secondary hydrolysis is not to complete the hydrolysis of the cellulose, but rather to hydrolyze the equilibrium reversion products resulting from primary hydrolysis (*5*). This secondary hydrolysis is just as necessary in the case of glucose submitted to simulated total hydrolysis as it is in the case of cellulose. The level of secondary hydrolysis required to reach maximum reducing power established by Hägglung (*10*) was checked by Gustafsson (*26*). Previous work at the Laboratory showed that accelerated hydrolysis with an autoclave gave the same yields as those obtained under reflux for a longer time (*22*). The autoclave has the further advantage of allowing 50 samples to be hydrolyzed simultaneously with no attention.

Procedure for the Total Hydrolysis of Wood and Pulp, and the Neutralization of the Hydrolyzate. Air-dry fluffed pulp or wood ground to pass a 30-mesh screen is weighed into a shell vial in an amount calculated to contain 0.30 gram of cellulose. Three milliliters of 72%

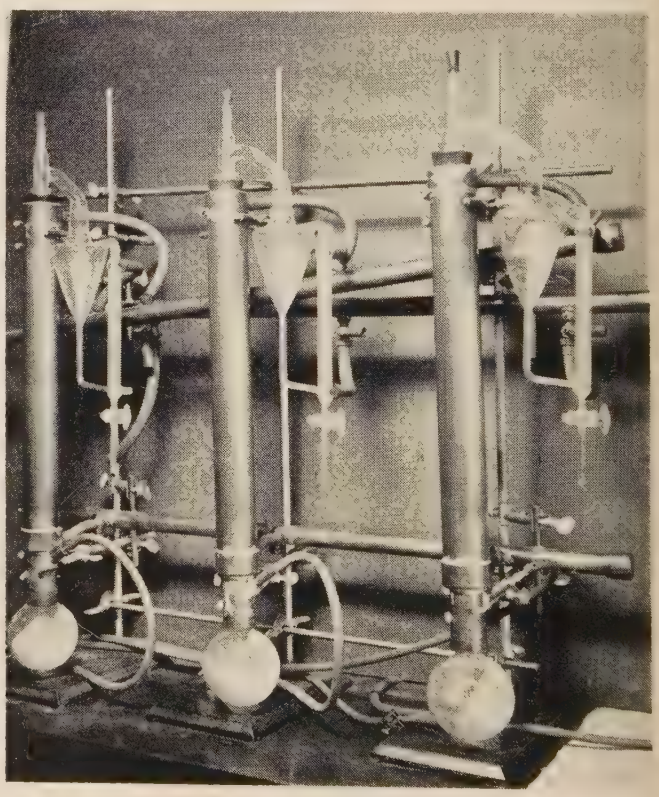

Fig. 2. Multiple evaporator setup

sulphuric acid are added and the vial is placed in a bath held at 30°C. ± ½°C. for 1 hr. The sample is stirred as required to effect solution of the cellulose. The contents of the vial are then transferred to a 250-ml. beaker with 84 ml. of water, and autoclaved for 1 hr. at a steam pressure of 15 ± 1 p.s.i. After cooling, the solution is stirred with about 25 grams of freshly washed Amberlite IR4B carbonate form ion-exchange resin. The exact amount of resin should be such as to raise the pH to 3.8 at a convenient rate, taking perhaps 20 to 30 min. The rate of change in pH after such an interval is conveniently slow. The sample is then decanted through a filter. For most work, quantitative washing is not necessary since the ratio of carbohydrate constituents supplies the desired information.

The Decomposition of Glucose, Mannose, Galactose, Arabinose, and Xylose, Subjected to Total Saccharification. Having established a rapid method of hydrolysis resulting in high yields of sugar, it was necessary to determine the exact losses of the various sugars. This was done by subjecting the individual sugars to simulated hydrolysis.

The experimental details were as follows: the procedure for total hydrolysis was that given above. The various sugars were subjected to 1 hr. of primary hydrolysis followed by 1 hr. of secondary hydrolysis. In parallel experiments, the series of sugars were subjected to 2×, 3×, and 4× normal primary hydrolysis, coupled respectively with 2×, 3×, and 4× normal secondary hydrolysis. The samples were neutralized with resin, which was then washed over a period of an hour to remove sugar. The recovered sugar was adjusted to 1 liter in volume and determined by means of the Somogyi copper reagent (*25*) and Nelson's arsenomolybdate solution (*16*).

Straight lines were obtained when the logarithm of the residual sugar was plotted against times of primary and secondary hydrolysis (Fig. 7). This is to be expected on the basis of known facts regarding the kinetics of sugar decomposition in strong and dilute acid (*14, 21*).

In the region of the dotted lines, the secondary hydrolysis is not sufficient to complete the hydrolysis of reversion products; therefore, the measured values for all sugars are below the dotted lines.

Individual sugar decomposition values are subject to relatively large experimental errors because of inherent variability in sugar analysis, hence the amount of decomposition or, conversely, the amount of each sugar surviving standard hydrolysis conditions (1 hr. each of primary and secondary hydrolysis) was determined from the curves in Fig. 7. These survival values are given in Table II.

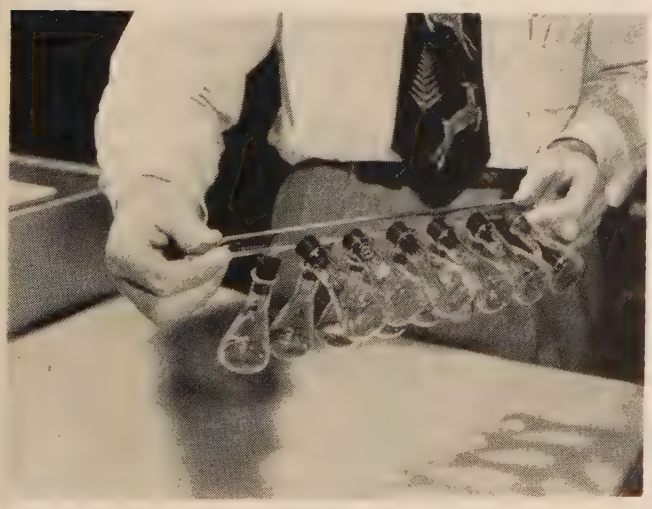

Fig. 3. Manifold for the evaporation of small volumes of solution

Fig. 4. Spotting chromatogram with mercury displacement microburet

The relative amounts of decomposition are nearly what should be expected on the basis of the rates of decomposition in dilute acid at high temperature (*21*). The recoveries of glucose and xylose differ considerably from those given by Gustafsson (*26*) due in part, perhaps, to the difference in method of hydrolysis.

An experiment was carried out to test the correctness of the recovery ratios given above for glucose and xylose.

A mixture was made of equal parts of glucose and xylose, the two sugars of the series showing the greatest difference in decomposition rates. This mixture was then separated chromatographically, both before and after simulated total hydrolysis. Application of the samples to the paper was such as to provide the equivalent of 90 gammas of glucose and 90 gammas of xylose on a 75-ml. strip. To correct for decomposition, the measured quantity of glucose and xylose remaining after hydrolysis was divided respectively by 0.974 and 0.912. The results are given in Table III. The original mixture containing 50% xylose appeared on analysis to contain 49.4% xylose. After the simulated total hydrolysis, and the application of correction factors, the apparent xylose content of the original mixture was 50.3%. These values are considered to be within the limits set by the errors involved.

Sugar Analysis

The separated sugars can be measured chemically or

Table II. The Amount of Various Sugars Surviving Total Hydrolysis

Sugar	*Amount of sugar surviving total hydrolysis, %*
Glucose	97.4
Mannose	96.2
Galactose	97.2
Arabinose	95.3
Xylose	91.2

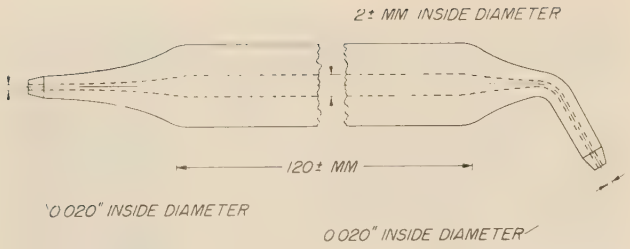

Fig. 5. Capillary elution pipet

by direct photometry of the colored spots on the paper. Such direct photometry has many advantages and has been established firmly by the group in the Finnish Central Laboratory (*7*).

In this work, where major emphasis is on the accurate determination of minimal quantities of "extraneous" carbohydrates, the chemical method was used.

Procedure for the Determination of Sugars

The improved sugar reagent of Somogyi (*25*) and the arsenomolybdate chromogenic reagent of Nelson (*16*) were used for all work.

Heating of the reagent with the sugar was accomplished by direct steam in a covered combination test tube rack and container. The rack consisted of two square perforated plates with 100 $^3/_4$-in. holes 1 in. on center. The test tubes, covered with marbles, were supported on a third plate with $^3/_8$-in. perforations. After 20 min. of steaming, the test tubes were chilled with cold water and the container was drained.

The quantities of reagents used varied with the amount of sugar to be determined. With an amount of sugar up to 50 gammas, $^3/_8$ ml. of sugar reagent was added to the $^3/_8$ ml. of eluate, followed after heating and cooling with $^3/_8$ ml. of chromogenic reagent. Minimizing the volume of reagents is favorable in that it minimizes errors due to the reagent blank. After shaking to expel carbon dioxide, the contents of the tube were mixed with $1^7/_8$ ml. of water to give a total volume of 3 ml., the least amount usable in the standard cells of the Beckman DU spectrophotometer.

With larger amounts of sugar, 1 ml. of copper reagent, 1 ml. of chromogenic reagent, and 3 ml. of water were used to give a total volume of $5^3/_8$ ml. and extend the range to 100 gammas. Doubling the total volume by using $8^3/_8$ ml. rather than 3 ml. of water doubles the range and makes the method suitable for as much as 200 gammas of sugar.

By reference to standardization curves, all density measurements are converted to glucose equivalents and

Table III. The Paper Chromatographic Separation of Equal Parts of Glucose and Xylose with and without Simulated Total Hydrolysis

	Glucose		Xylose		
Treatment	*Average of four, gammas*	*Standard deviation, gammas*	*Average of four, gammas*	*Standard deviation, gammas*	*Based on total sugar, %*
Without hydrolysis	91.3	1.1	90.2	0.9	49.7
	90.6	1.8	88.8	2.2	49.5
	92.4	2.3	89.5	2.7	49.4
After total hydrolysis	90.0[a]	0.5	90.5[a]	1.1	50.1
	89.8[a]	1.0	90.5[a]	2.2	50.4
	89.5[a]	0.8	90.7[a]	1.6	50.3

[a] Corrected for decomposition resulting from hydrolysis.

Table IV. Relative Reducing Power of the Various Sugars

Sugar	*Relative reducing power*
Glucose	1.000
Mannose	0.879
Galactose	0.774
Arabinose	0.866
Xylose	0.984

then corrected for the paper blank. The values obtained are then divided by the appropriate correction factor in Table IV to give the amounts of the various sugars.

In the sugar analyses described, all pipetting makes use of hand-operated syringe pipets. With such pipets, 20 deliveries may be made per minute with an error of about 0.001 ml.

By weighing a series of test tubes containing the components required for sugar analysis, it was determined that the total errors due to evaporation and pipetting were of the order of 2 parts per 1000. Depending on the skill and care of the operator, errors due to sugar analysis alone can be kept consistently to ±1 or 2 gammas over the range of 0 to 100 gammas, and with larger amounts of sugar to ± 1 or 2% of the sugar determined.

Interfering Substances in the Chromatographic Determination of the Carbohydrate Constituents of Pulps

An experiment was carried out to determine the interference caused by decomposition products resulting from total saccharification and from possible contaminants in the reagents and ion-exchange resin.

The following samples were prepared for this study: (1) pure glucose dissolved in distilled water; (2) glucose dissolved in water acidified with the acid required for hydrolysis and then neutralized to pH 3, pH 4, and pH 5; (3) glucose subjected to a total saccharification procedure and then neutralized to pH 3, pH 4, and pH 5; and (4) an acid solution of the same composition as in (2) and (3) neutralized to pH 4.

Chromatograms were carried out in the usual way at loadings of 2500 and 5000 gammas of sugar per 75-ml. width of paper. In the case of the reagent and ion-exchange resin blanks, loadings were such as to correspond to the sugar loadings. The results are shown in Table V where average values are given for duplicates of the two loadings.

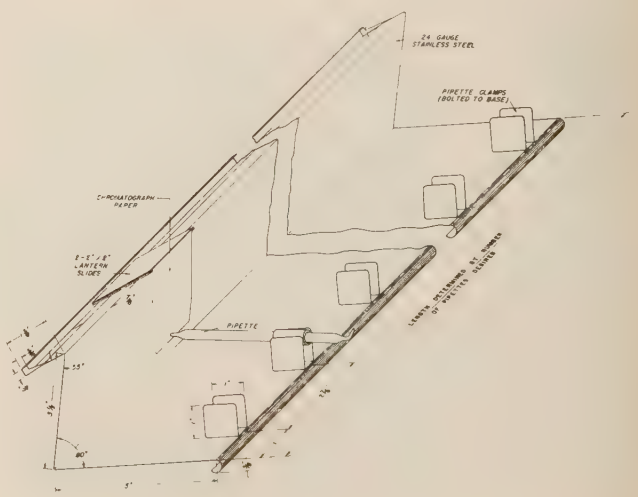

Fig. 6. Elution rack and capillary pipet for recovering sugars from chromatogram

Table V. Reducing Material as Glucose Resulting from the Simulated Total Hydrolysis of Glucose

Location on sheet, R-glucose	Glucose hydrolyzed and neutralized, % pH 3.0	pH 4.0	pH 5.0	Glucose acidified and neutralized, % pH 3.0	pH 4.0	pH 5.0	Glucose in distilled water, %	Hydrolysis and neutralization blank, pH 4.0, %
0.70	0.02	0.04	0.13	0.06	0.09	0.15	0.06	−0.03
1.30	0.19	0.17	0.20	0.04	0.04	0.04	0.04	0.02
1.55	0.05	0.09	0.05	0.07	0.07	0.08	0.06	0.04
1.80	0.07	0.11	0.10	0.04	0.01	0.01	0.09	0.07

Average of two determinations at 2500-gamma loading and one determination at 5000-gamma loading; corresponding volumes of liquid used for hydrolysis blank.

Pure glucose, acidified glucose, and the reagents contain only minor amounts of interfering substances. Reducing substances are produced by the simulated hydrolysis of glucose and are found on the chromatogram at R-glucose values corresponding approximately to mannose and at a point beyond xylose, the most mobile of the sugars under consideration. A pH of 3 to 4 is a satisfactory end point in the neutralization, but there is some indication that a pH of 5 may increase the interference.

Another experiment was performed to evaluate more accurately the interference in the mannose and xylose area. The results are given in Table VI.

The variable blank in filter paper and errors in sugar analysis make it difficult to determine accurately the small amounts of interfering materials. The negative values of Table VI are due to such errors. It is considered that this work sets the upper limit for interference by sugar decomposition products. In work at the Laboratory, measured values for mannan are reduced by 0.15% to compensate for the error. On the basis of the data at hand, there is negligible interference with the xylan determination. The material responsible for this interference at R-glucose = 1.30 was eluted from a chromatogram, respotted on a paper, and rechromatographed using ethyl acetate, acetic acid, and water. The material was resolved into two main components, one appearing slightly above a known mannose spot, and the other slightly below mannose. No further work was done on the identification of the material.

Solvent Systems

No attempt will be made to discuss the many solvent systems available for work with pulps. Much of the work at the Laboratory has been on the carbohydrates of purified pulps or modified celluloses containing only glucosan, xylan, and mannan. The butanol-pyridine-water system has proved satisfactory for this purpose. This system fails to resolve mannose and arabinose, and in the presence of large amounts of glucose, the galactose and glucose spots overlap. In pulps containing these carbohydrates, the galactose-glucose ratio can be determined by extending the time of irrigation; in which case, the xylose is lost. Mannose and arabinose can be separated by rechromatographing, using the ethyl-acetate solvent system.

Table VI. Reducing Material, Generated by the Total Hydrolysis of Glucose, That Interferes with the Mannose and Xylose Determination

Location on sheet, R-glucose	Reducing material 2550-gamma loading, gammas	5100-gamma loading, gammas
1.30 (mannose)	5.3	8.7
	3.3	5.9
	3.3	9.0
	4.2	9.2
Average	4.0	8.2
1.60 (xylose)	−1.4	−2.0
	−2.5	−1.9
	−1.8	−1.4
	−1.1	−1.5
Average	−1.7	−1.7

Determination of Pentosans in Purified Pulps

Paper chromatography was investigated to determine its advantages and its limitations as an independent reference method for the determination of pentosans in purified pulps.

The data of Table VII show the accuracy with which xylose can be determined in the presence of large amounts of glucose. The errors due to chromatography and to sugar analysis are of the order of 1 to 2 gammas or less. At a loading of 4000 gammas of total sugar, an error of 2 gammas in the pentose determination amounts to 0.05% uncertainty based on the total carbohydrate.

The data of Tables V and VI show that at the maximum loading, the hydrolyzed glucose caused a negligible amount of material to appear in the xylose location. The actual measured value was −0.03%. Such small negative values can arise from the variability in the paper blank and in the sugar analysis.

Paper chromatography was used to determine the pentosan content of a series of pulps prepared from red gum by the prehydrolysis sulphate method. All pulps were part of the same series, prepared from the same batch of wood, and included matched pairs purified in different ways. None of the pulps contained arabinose. When the results obtained by chromatography were plotted against those obtained by the TAPPI procedure, the results of Fig. 8 were obtained. At

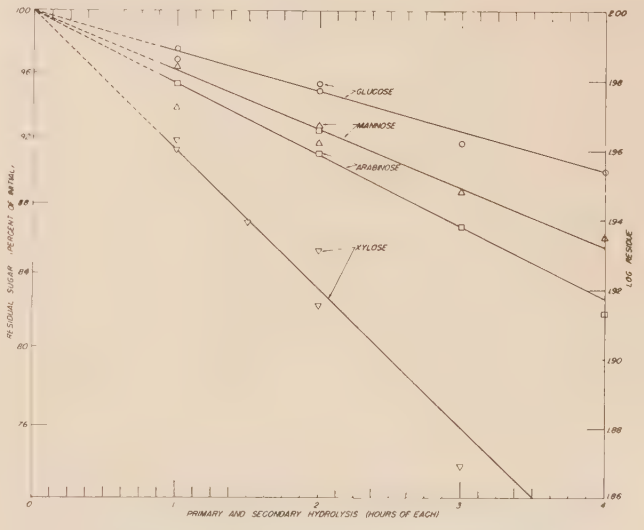

Fig. 7. Effect of time of primary and secondary hydrolysis on the decomposition of various monosaccharides

Table VII. The Determination of Xylose in the Presence of Large Amounts of Glucose

Glucose to xylose	Xylose applied, gammas	Xylose recovered (average of four), gammas	Standard deviation, gammas	Error in recovery (average of four), gammas
100:4	80	81.3	0.9	1.3
100:3	120	119.5	0.2	−0.5
100:2	80	80.4	1.4	0.4
100:2	80	80.6	2.2	0.6
100:1	40	40.5	0.3	0.5
100:1	40	40.8	0.3	0.8
200:1	20	21.2	0.6	1.2
200:1	20	21.7	0.7	1.7

pentosan contents above 5, the agreement between the methods is satisfactory. At pentosan contents below 5 there is increasing discrepancy with decreasing pentosan content. Differences of 10 to 20% are clearly indicated at pentosan contents of about 2%.

Effect of Incomplete Conversion of Pentosan to Pentose on the Precision of the TAPPI Pentosan Determination. Difficulties in the conventional TAPPI pentosan determination arise from four main sources: (1) the conversion of pentosan to pentose; (2) the conversion of pentose to furfural and its removal from the reaction zone; (3) the analytical determination of furfural; and (4) the correction and conversion factors involved.

Work in this Laboratory and elsewhere (*12*, *24*) has shown that pentosans resist hydrolytic removal from pulp. The extent of this resistance was measured at the Laboratory by subjecting pulp samples to increasing periods of hydrolysis with constant boiling hydrochloric acid at the boiling point and then analyzing the residues. Measurements were made of the residual cellulose and the residual mannan and xylan contained in the residue. To avoid complications due to insoluble acid decomposition products, the method of Millett (*15*) was used to carry out the hydrolysis. The results are given in Fig. 9 for a sample of regular kraft southern pine pulp. It is seen that a portion of the pentosans in pulp is very resistant to removal, and it is doubtful whether a pentosan-free residue can be made in this way. It is very similar in this respect to the mannan in pulp (*30*).

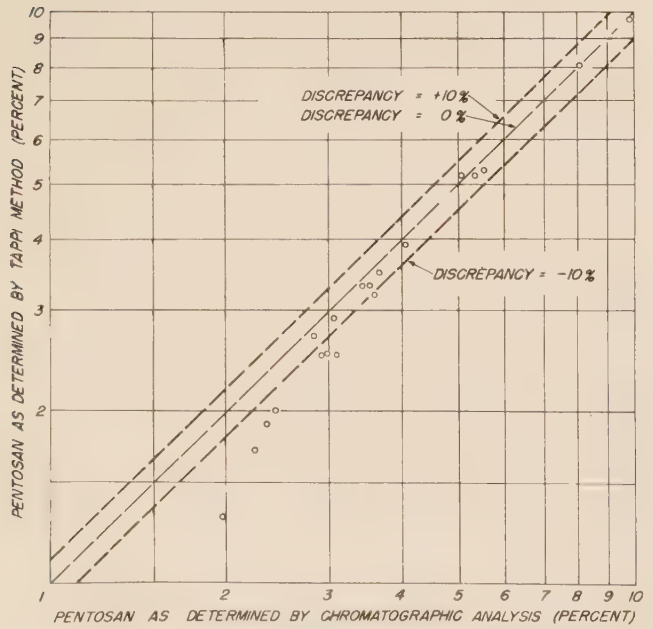
PENTOSAN AS DETERMINED BY TAPPI METHOD (PERCENT)
PENTOSAN AS DETERMINED BY CHROMATOGRAPHIC ANALYSIS (PERCENT)
DISCREPANCY = +10%
DISCREPANCY = 0%
DISCREPANCY = −10%

Fig. 8. Comparison of chromatographic and TAPPI pentosan determinations

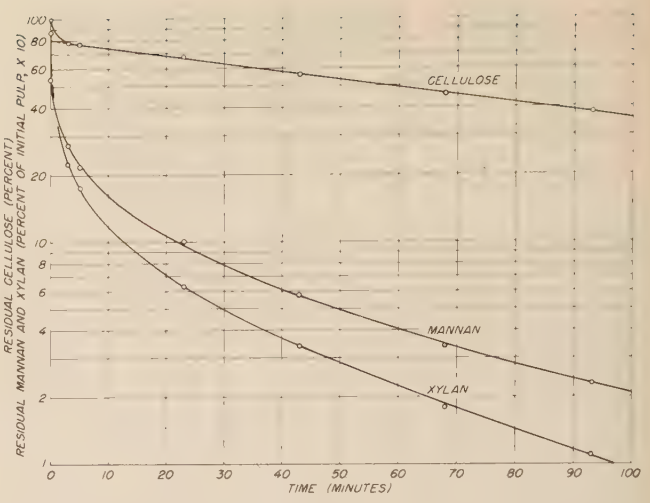

Fig. 9. Residual cellulose, mannan, and xylan as a function of time of hydrolysis with constant boiling hydrochloric acid

In another experiment, samples of pulp were analyzed by the TAPPI procedure, and the insoluble residues were examined for their pentosan content. The results are given in Table VIII.

With decreasing pentosan content, the deviations from chromatographic results due to undissolved pentosan increase. This undissolved pentosan, however, accounts for only part of the differences indicated in Fig. 8 for the low-pentosan region. Additional losses are undoubtedly sustained during the conversion of pentose to furfural and in the removal of furfural from the reaction zone. The matter is further confused by uncertain correction and conversion factors.

This work is considered to show fundamental discrepancies in the TAPPI pentosan procedure. These are independent of the method used to estimate the furfural, and are due to slow and incomplete conversion of pentosan to soluble pentose and thence to furfural at the point of analysis.

It is considered that a more accurate pentosan determination for purified pulps should follow total hydrolysis, followed by some suitable means for estimating the pentose content. Such a study is now in progress.

The precision of paper chromatographic methods as described is barely adequate for the determination of pentosans in purified pulps. This work shows that the limitations of the method are set by the limitation on the possible loading of the paper, and the uncertainties in paper blank, sugar analysis, and possibly in the reducing substances generated by hydrolytic decomposition of carbohydrate during total hydrolysis.

The precision of the paper chromatographic determination of pentosans can be improved by washing the

Table VIII. Pentosans in Cellulose Residues from the TAPPI Pentosan Determination

Pentosan content of pulp by TAPPI method, %	Carbohydrate in residue (based on pulp), %	Pentosan in residue (based on residual carbohydrate), %	Pentosan in residue (based on initial pentosan), %
1.3	37.2	0.24	6.8
2.5	37.0	0.26	3.8
15.3	32.0	0.50	1.0

paper prior to use to eliminate or greatly reduce the paper blank; by heavier loading of the sample on thick paper; and by making a more exact determination of interfering materials. Such work is now in progress at the Forest Products Laboratory.

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An Investigation of the Reasons for Increase in Paper Strength when Locust Bean Gum Is Used as a Beater Adhesive

HOWARD J. LEECH

The strength of paper depends upon the strength of the fibers, the strength of the bonds, the number of bonds, and the formation (distribution of fibers and bonds). Beater adhesives which increase paper strength must accomplish the improvement by affecting one or more of the factors contributing to paper strength. Studies were made to evaluate the effects of the number of bonds and the formation upon paper strength. It was determined that increased bonding and improved formation produced stronger paper. Locust bean gum brought about a much greater increase in paper strength than could be attributed to improved formation or increased area of bonding. Bonding strength tests indicated that the major effect of locust bean gum was to increase the strength of the bonds. The increase in bond strength is attributed to greater bond flexibility because of the participation of the locust bean gum molecule in bonding. The increase in strength brought about by locust bean gum is ascribed to increased strength of the bonds (60%), improved formation (25%), and increased number of bonds (15%).

Nonfibrous materials have been added to pulp suspensions for many years in an attempt to improve some quality of the paper. A wide variety of materials have been used to alter both surface and strength properties of paper. One class of materials which is used to improve the strength properties of paper has been called beater adhesives. The materials of this class consist chiefly of naturally occurring high polymeric materials and cellulose derivatives. All the materials in this group are, chemically speaking, polysaccharides or derivatives of polysaccharides. It has frequently been reported that very large strength increases are obtained when this class of beater adhesives is used. In many cases reasons have been suggested to explain the strength increases, but no actual study of the reasons for the strength increase has yet been made. The object of the present work was to investigate the relative importance of the various factors which may contribute to the strength increase obtained with beater adhesives.

EFFECTS OF BEATER ADHESIVES

Although starch has been used for centuries in the paper industry, it was not until Hunter (*1*) revealed that *Hibiscus manihot* was used by the Japanese to obtain good formation with long-fibered pulp that

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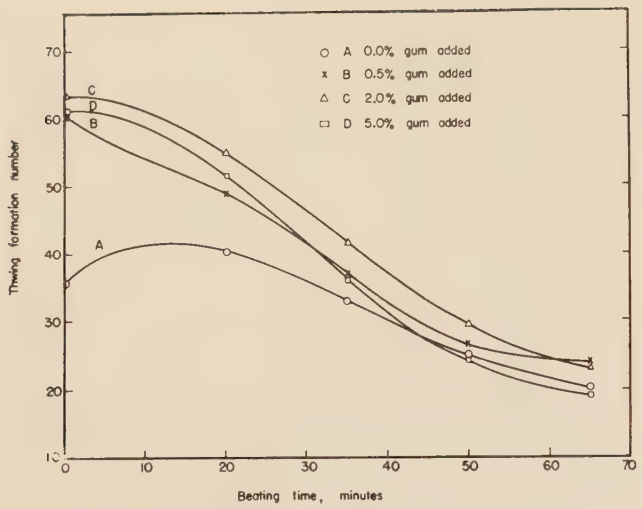

Fig. 1. Formation-beating time relationship

wide interest was awakened in the field of beater adhesives. Since that time a great number of materials have been tested for their suitability as beater adhesives. Broadbent and Harrison (*2*) found that *Hibiscus manihot* and deacetylated karaya gum were particularly effective adhesives. They observed that these materials not only swelled in water to form gelatinous masses but also exhibited ropiness. Swanson (*3*) found that guar and locust bean gum produce very appreciable strength increases. It was pointed out that great power savings may be realized by use of the adhesives, because these materials appear to advance the beating effect. Swanson's work also showed that the strength properties of papers containing guar or locust bean gum are superior to those containing no adhesive, even at the optimum beating time. The adhesive is reportedly adsorbed by the fibers in the form of a highly swollen mucilage. Swanson has noted improvements in formation which he attributed to a hydrophilic layer on the pulp and a negative electrokinetic potential. LeCompte (*3a*) has perfected a method for making a paper fiber deflocculent from karaya gum. Wollwage (*4*) reported that deacetylated karaya gum reduced the flocculation tendency of pulp suspensions and Erspamer (*5*) correlated this with sheet formation. Erspamer found locust bean gum to be an especially powerful dispersing agent.

Many suggestions have been made to explain the beneficial effect of beater adhesives. Horsey (*6*) and Rowland (*7*) proposed that the free hydroxyl groups on the adhesive promote additional bonding. Musser and Engel (*8*) listed increased swelling and actuation of fibrillation as possible reasons. They also suggested improvement in formation by a deflocculating action. Dixson (*9*) and Swanson (*3*) emphasized the importance of colloidal phenomena. Cobb (*10*) and Musser and Engel (*8*) proposed that the adhesive may improve fiber bonding by a cementing action. Broadbent and Harrison (*2*) attribute the strength increase entirely to improved formation. An excellent review of the field of beater adhesives has been published by Jayne and co-workers (*11*).

BONDING IN PAPER

Although a complete discussion of the field of paper strength is beyond the scope of this article, a few outstanding contributions should be mentioned. It has been well established that a major portion of the strength of paper can be attributed to bonds formed between adjacent fibers in the sheet. The bonds involved are not due to mere mechanical entanglement of fibers. Unbonded sheets as prepared by Parsons (*12*) were found to be extremely weak. Van den Akker (*13*) found that sheets which were frozen while wet and were dried by sublimation of the ice were also very weak. Clark (*14*) pressed wetted sheets of viscose cellophane together and dried them. He found that the sheets stuck together very firmly. Thus, it is seen that other forces than mechanical entanglement were involved in the bonding of cellulose surfaces.

The type of bonds which contribute so greatly to paper strength are hydrogen bonds formed by the mutual attraction of polar hydroxyl groups of cellulose. Bletzinger (*15*) has shown that acetylation of cotton fibers greatly decreased the strength properties of sheets produced from the fibers. Acetylation covers the polar hydroxyl groups which participate in hydrogen bonding. Deacetylation of the pulps produced fibers which gave sheets with strength properties similar to the original pulp. Kress and Bialkowsky (*15a*) have also demonstrated the importance of swelling of pulps with respect to beating and bonding. It is known that swelling is closely associated with the hydroxyl groups of cellulose.

STUDY OF THE REASONS FOR STRENGTH INCREASE WITH BEATER ADHESIVES

The strength of a sheet of paper is primarily dependent upon four factors. These are: (1) the strength of the fibers, (2) the strength of the bonds, (3) the number of bonds, (4) the distribution of fibers and bonds (formation). It is felt that beater adhesives bring about increases in paper strength by affecting one or more of these factors. In order to determine how a beater adhesive accomplishes an increase in paper strength, a study must be made of the effect of the adhesive upon each of the factors contributing to paper strength. The results of this study must be related to the effect of the adhesive upon the strength properties and to the effect of any of the factors upon the strength properties. Since the adhesive probably produces an effect upon more than one

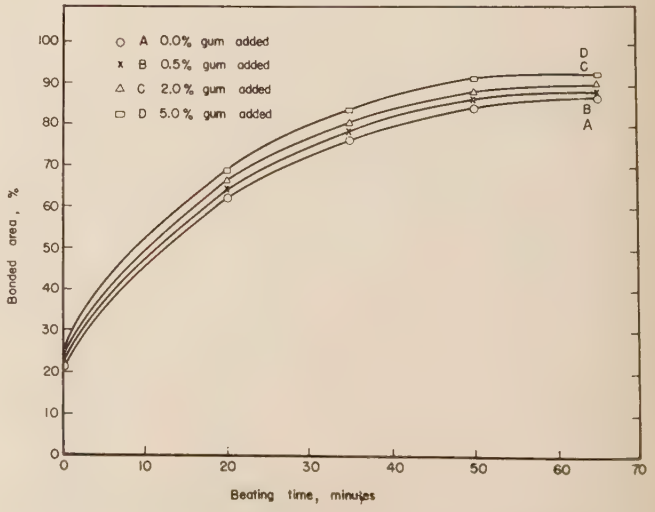

Fig. 2. Bonded area-beating time relationship

factor, it is necessary to determine the effect of changes in the individual factors upon the paper strength in the absence of the beater adhesive.

Changes in formation and the number of bonds are readily produced by control of the sheetmaking and wet pressing conditions. The changes in strength properties accompanying the changes in one factor (e.g., formation) can then be readily determined. Comparison of the changes in strength properties produced by the adhesive with those produced by changes in formation alone (in the absence of the adhesive) should reveal the importance of any change in formation produced by the adhesive. That is, a given change in formation would produce a given change in strength properties (in the absence of the adhesive) and only a corresponding change in strength properties could be attributed to the change in formation produced by the adhesive. Any other change in strength properties must be due to a change in one of the other factors caused by the presence of the adhesive.

If compounded variations of formation and the number of bonds are produced (in the absence of the adhesive), the strength of the bonds in sheets with and without adhesives can be compared at similar levels of formation and at a similar number of bonds. In this manner the effect of the adhesive upon the strength of the bonds could be ascertained. Subsequently, the effect of the strength of the bonds could be related to paper strength.

Variations in fiber strength are not easily produced. Consequently, for this study only the effect of the adhesive upon fiber strength was determined.

PROCEDURE

On the basis of the results obtained by Swanson (*3*) the adhesive chosen for this study was locust bean gum. The gum was purified according to a procedure described by Haug (*16*). The gum was used in the experiment as a 0.5% dispersion which was prepared by adding the dry gum very slowly to vigorously agitated water and heating the resultant mixture. The pulp used for the experiment was a coniferous bleached sulphite pulp which was also chosen on the basis of Swanson's work (*3*).

The pulp was beaten in a laboratory Valley beater

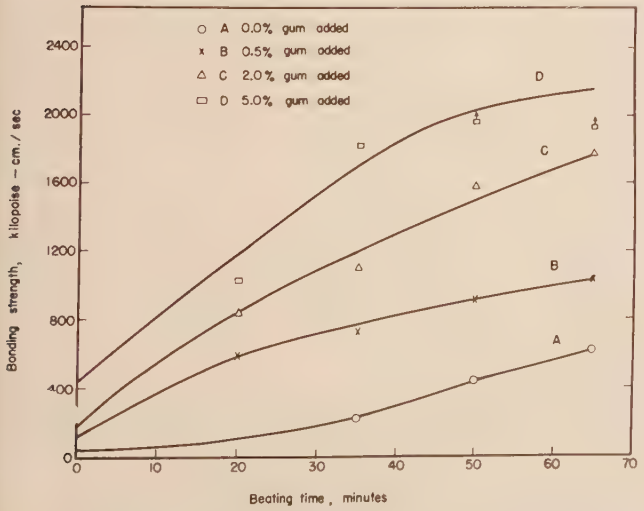

Fig. 3. Bonding strength-beating time relationship

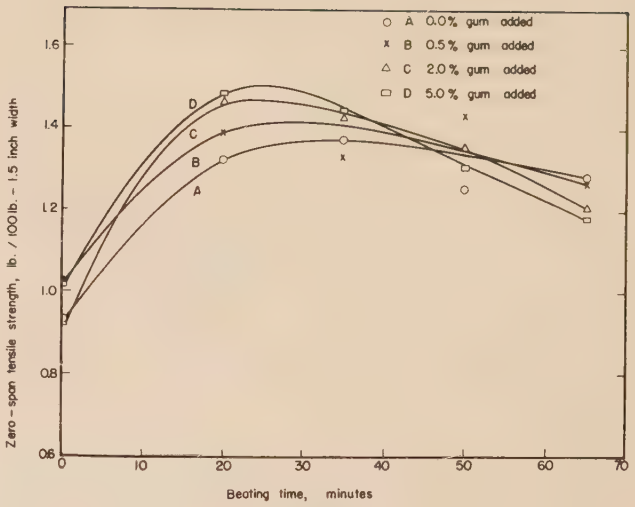
A 0.0% gum added
B 0.5% gum added
C 2.0% gum added
D 5.0% gum added
Zero-span tensile strength, lb. / 100 lb. – 1.5 inch width
Beating time, minutes

Fig. 4. Zero-span tensile strength-beating time relationship

in the normal manner using a bedplate loading of 5500 grams. At the end of the desired beating interval, the contents of the beater were dropped and a fresh batch of pulp was used for the next beating interval. The beating intervals were 0, 20, 35, 50, and 65 min. Appropriate amounts of the locust bean gum dispersion were added after the beating and sufficient time was allowed for attainment of equilibrium adsorption of the gum. The quantities of gum added (based on the pulp) were 0.0, 0.5, 2.0, and 5.0%. The sheetmaking and wet pressing conditions which were used are indicated below.

Sheetmaking condition	*Volume in British sheet mold, ml.*	*Flocculation time, sec.*
A	1000	30
B	2000	20
C	7000	15
D	7000	0

Wet pressing condition, p.s.i.	*First pressing, 5 min., p.s.i.*	*Second pressing, 2 min., p.s.i.*
15	15	15
50	50	50
200	50	200
1000	50	1000

The standard conditions used for all sheets containing locust bean gum were sheetmaking condition C and wet pressing condition 50 p.s.i. The compounded variations of formation and number of bonds were made on the 35 and 50-min. beating intervals.

Measurement of the strength of the fibers was made by the zero-span tensile test. It was realized that bonding has a minor effect upon the test as has been reported by Forman (*17*) but the test was considered acceptable for the present study. Formation was measured by the Thwing formation tester (*18, 18a*) and the extent of bonding was measured by the optical methods of Parsons (*12*), as modified by Ratliff (*19*). The measure obtained is the bonded area which is believed to be proportional to the number of bonds. The strength of the bonds was measured on the newly developed I.P.C. bonding strength tester (*20*). The instrument applies a stress to the bonds through a viscous film of polyisobutylene. A wheel carrying a thin film of polyisobutylene rolls over the surface of the

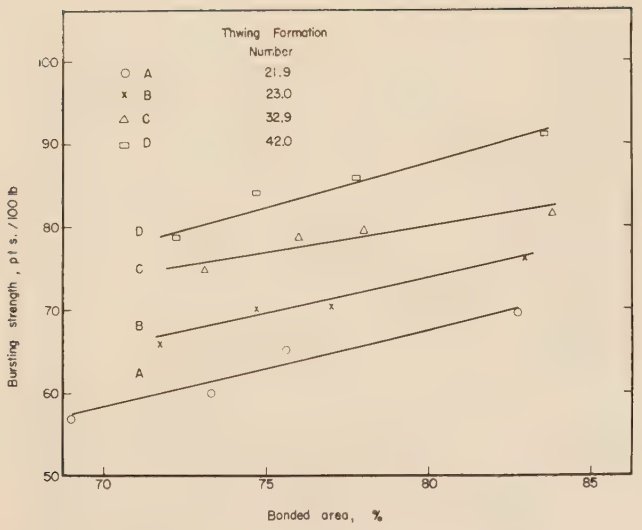

Fig. 5. Bursting strength-bonded area relationship in which no gum was added and a 35-min. beating interval was used

paper, and the stress applied as the wheel leaves the surface of the paper is dependent upon the viscosity of the polyisobutylene and the velocity of separation of the surfaces.

The strength properties of the papers measured were the bursting strength test, the Elmendorf tear test, and the load-elongation test (tensile and stretch). Other tests carried out were S.-R. freeness, specific surface (silvering), and locust bean gum content. The technique for the measurement of the locust bean gum content was developed especially for this work. The method consisted of hydrolysis with 3 to 5% sulphurous acid at 135°C. for 80 min., recovery of the sugars, separation of the sugars by paper partition chromatography, and determination of the galactose (from locust bean gum) by oxidation with sodium periodate.

The data collected from the experiment are shown in Table I. Figs. 1 to 9 are all based upon the data in this table. The bonding strengths of samples 1 to 5 are to be regarded with suspicion because an improper prefilming technique was used. Prefilming has been used with all other samples to eliminate the effect of surface roughness. The bonding strengths of samples 30 and 50 were so great that no rupture occurred. The locust bean gum content of sample 48 is obviously incorrect. Examination of the chromatograms revealed incomplete separation of glucose and galactose which probably caused the erroneous result.

DISCUSSION OF RESULTS

The characteristic beating curves and the effect of locust bean gum upon these curves are not reproduced because of the marked similarity to those given by Swanson (*3*). The interpretation and significance of the curves have been fully covered by Swanson and need no further mention. Figures 1 to 4 illustrate the effect of beating and of locust bean gum upon the four factors which contribute to paper strength. It will be seen that beating causes an initial improvement in formation. However, as beating is continued the formation value of the paper decreases. This effect is believed to be due to an increase in the time available for flocculation of the fibers in the sheet mold because of slower drainage (lower freeness) of more highly beaten pulps. The effect of locust bean gum upon the formation is most pronounced at the early stages of beating where great improvements were obtained. It will be seen that the formation values of the sheets made with 5.0% gum were quite poor during the later stages of beating. The poor formation was due principally to slow drainage.

Beating caused a regular increase in the percentage of area bonded (as measured by the optical method.) The data confirm work published by Nordman (*21*). It will be seen that the presence of locust bean gum causes small regular increases in the percentage of bonded area. This is interpreted as a corresponding increase in the number of bonds.

Examination of the effect of beating upon the bonding strength of paper reveals an increase in bonding strength as beating proceeded. The relative increase is greater than the corresponding relative increase in bonded area. The increase represents an increase in the actual strength of the bonds. This, in turn, would suggest either that stronger bonds were formed because of greater opportunity for orientation of cellulose chains during bonding or that the beaten fibers were sufficiently more flexible that a less stressed structure was formed upon drying. Nordman and co-workers (*22*), using a different technique, came to the conclusion that the strength of the bonds was independent of the degree of beating.

The effect of locust bean gum upon bonding strength was very pronounced. The use of even 0.5% locust bean gum doubled the bonding strength. Comparison of the changes brought about in bonding strength by the gum with changes in the other factors affecting paper strength would lead immediately to the belief that the principal function of the gum was to increase the strength of the bonds. However, no such conclusion could be justified unless it was shown that changes in bonded area and formation have a small effect upon paper strength (as compared with the effect of locust bean gum).

The effect of beating upon zero-span tensile strength is shown in Fig. 4. It will be seen that zero-span tensile strength reaches a maximum and then declines

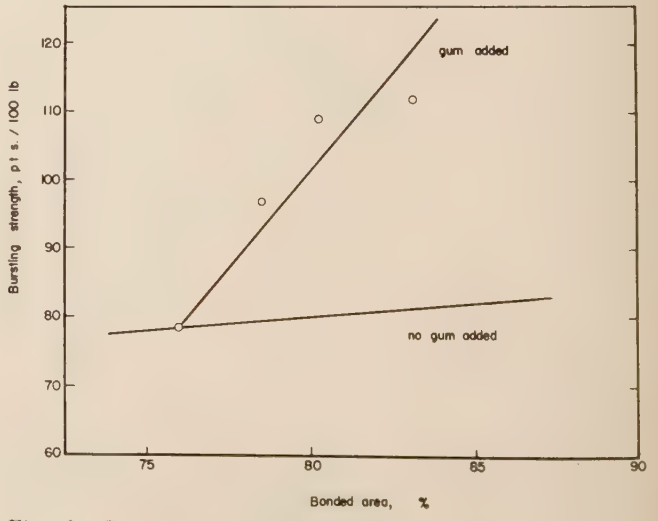

Fig. 6. Bursting strength-bonded area relationship—35 min.

as beating proceeds. This is in agreement with earlier work with the zero-span tensile test reported by Forman (*17*). The initial increase is believed to be caused by the effect of bonding, whereas the decrease is believed to be a result of actual weakening of the fiber during the beating process. The effect of locust bean gum upon the zero-span tensile strength is to cause an additional increase in the early stages of beating, followed by a sharp decrease. The early increase in zero-span tensile strength is attributed to increased bonding. It would appear, as with other measures of strength, that the gum has the effect of advancing the action of beating. The strong decrease in zero-span tensile strength may be a result of this effect. It appeared that the magnitude of changes in zero-span tensile strength involved when locust bean gum was used were small. Thus, it seems reasonable to conclude that the great increase in strength properties brought about by locust bean gum are not due to any change in the strength of the fibers (caused by the gum).

Figure 5 shows bursting strength as a function of bonded area for several values of formation (for the 35-min. beating interval). From this figure, the effect of changes in bonded area or changes in formation upon bursting strength can be ascertained. The changes involved represent the independent effect of one factor upon bursting strength. Similar graphs result from plots of the other strength properties against bonded area, and for the 50-min. beating interval.

As would be expected from the theories of bonding, bursting strength and tensile strength are increased by increase in bonded area, whereas tearing strength decreases with increasing bonded area. Elongation would appear to be almost independent of bonded area. Bursting strength and tensile strength also show increases with improved formation. This is certainly to be expected, because both tests are tests of the weakest parts of the paper. Improved formation produces a more uniform sheet which is less apt to have weak portions. The tearing strength appears to be a weaker function of formation. This is also to be expected because the tearing strength represents the average force required to tear the sheet and thus should not be greatly dependent upon formation. Higher values of elongation appear to be obtained with papers having

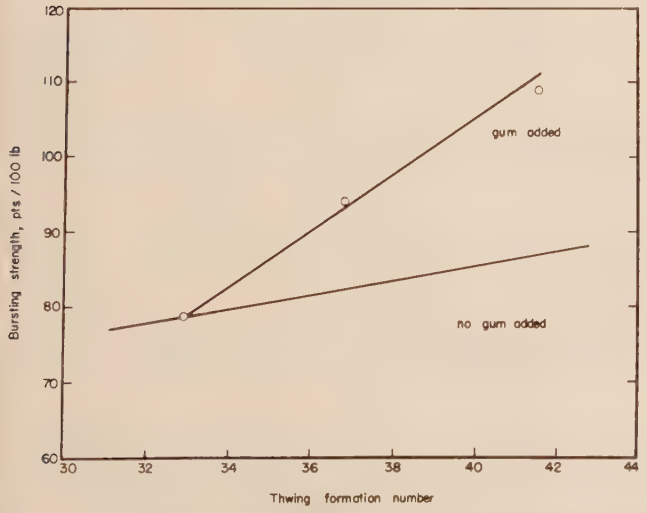

Fig. 7. Bursting strength-formation relationship—35 min.

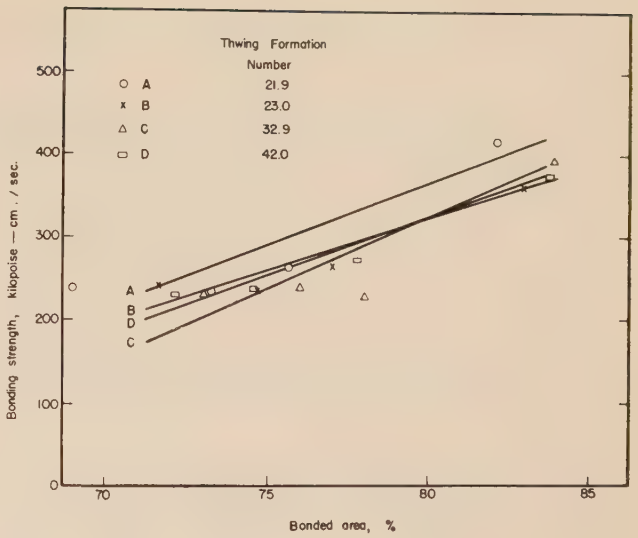

Fig. 8. Bonding strength-bonded area relationship in which no gum was added and a 35-min. beating interval was used

better formation. The reason is probably that more uniform stresses (and corresponding strains) are produced when papers having high formation values are subjected to load-elongation testing.

Figures 6 and 7 show a comparison of the effect of locust bean gum upon bursting strength with the independent effect of bonded area and formation, respectively, upon the bursting strength. Again, the 35-min. beating interval is shown. In each case, the line for "no gum added" was obtained from Fig. 5. The line was so chosen that the effect of only one factor is involved and that the line passes through the "standard conditions, no gum added" point (i.e., sample 21 for 35 min. beating time). The important aspect of these diagrams is the relative slopes of the "gum added" and "no gum added" lines. The slope in Fig. 6 represents the change in bursting strength corresponding to a change in bonded area. Only if the lines of "gum added" and "no gum added" were coincident could it be said that the improvement in bursting strength brought about by locust bean gum was due solely to increases in bonded area. This is very obviously not the case. The diagram shows that only a small portion of the increase in bursting strength brought about by locust bean gum can be attributed to an increase in bonded area.

Thus, it is shown that the improvements in bursting strength obtained with locust bean gum can be partially attributed to increases in bonded area and partially to improvements in formation. However, in both cases, the contribution of these factors is small compared with the total improvement produced by the gum. The same may be said for the contribution of these factors to tensile strength.

The decrease in tearing strength caused by the gum is due largely to the effect of increased bonded area. In accordance with the theory of the tear test, the presence of a large number of bonds can decrease the tearing strength by causing rupture of the fibers instead of by separation of the fibers intact. Apparently, this is the effect observed here. The contribution of formation to the total change in tearing strength is small, as would be expected.

Locust bean gum brought about very slight changes

Table I. Summary of Experiments

Sample	Beating time, min.	Locust bean gum added, %	Sheet forming condition	Wet pressing condition, p.s.i.	Freeness, ml. S.-R.	Specific surface, sq. cm./g.	Locust bean gum content, %	Basis weight (25×40—500), lb.	Thwing formation no.	Bonded area, %	Bonded area, sq. cm./g.	Bonding strength, kilopoise-cm./sec.	Zero-span tensile strength (1.6 in. width), lb./100 lb.	Bursting strength, pt./100 lb.	Tear factor, g. per sheet/100 lb.	Tensile strength (1.5 in. width), lb./100 lb.	Elongation, %
1	0	0.0	C	50	900	7,630	..	44.1	35.9	21.5	1,640	(48)	0.932	18.1	1.03	0.079	2.0
2	0	0.5	C	50	895	...	0.16	44.3	60.4	23.2	1,770	(120)	1.023	18.1	1.50	0.156	2.6
3	0	2.0	C	50	905	...	0.76	45.7	63.4	25.0	1,910	(176)	0.923	18.6	1.97	0.171	3.3
4	0	5.0	C	50	905	...	0.59	46.1	61.0	24.0	1,830	(447)	1.013	19.5	1.96	0.186	3.5
5	20	0.0	C	50	810	10,500	..	47.4	40.2	62.4	6,550	(312)	1.312	69.4	1.39	0.633	5.3
6	20	0.5	C	50	790	...	0.44	46.2	48.7	64.2	6,730	574	1.387	90.9	1.19	0.755	6.2
7	20	2.0	C	50	740	...	1.52	45.8	54.7	66.3	6,960	833	1.465	95.6	1.06	0.825	6.8
8	20	5.0	C	50	720	...	1.90	45.4	51.6	68.8	7,220	1022	1.486	102.6	0.99	0.828	6.6
9	35	0.5	C	50	590	...	0.56	44.8	36.8	78.5	9,700	719	1.333	94.0	0.93	0.788	6.8
10	35	2.0	C	50	465	...	1.49	46.0	41.5	80.3	9,910	1088	1.430	108.9	0.88	0.876	6.8
11	35	5.0	C	50	380	...	2.27	46.1	36.1	83.2	10,270	1818	1.440	111.9	0.86	0.902	6.9
12	35	0.0	A	15	..	...	..	46.2	..	69.0	8,510	240	...	56.7	1.29	0.556	4.0
13	35	0.0	A	50	..	...	..	47.2	21.9	73.3	9,040	235	...	60.2	1.16	0.587	4.2
14	35	0.0	A	200	..	...	..	46.4	..	75.6	9,330	262	...	65.3	1.14	0.672	4.5
15	35	0.0	A	1000	..	...	..	47.4	..	82.8	10,200	414	...	69.6	1.02	0.722	4.8
16	35	0.0	B	15	..	...	..	45.3	..	71.7	8,840	240	...	66.0	1.20	0.638	4.4
17	35	0.0	B	50	..	...	..	46.3	23.0	74.7	9,210	235	...	70.0	1.16	0.672	4.6
18	35	0.0	B	200	..	...	..	46.1	..	77.0	9,500	261	...	70.3	1.16	0.703	4.8
19	35	0.0	B	1000	..	...	..	45.8	..	83.0	10,220	357	...	76.0	0.99	0.723	4.7
20	35	0.0	C	15	..	...	..	47.3	..	73.1	9,020	230	...	74.8	1.21	0.641	5.9
21	35	0.0	C	50	570	12,370	..	45.7	32.9	76.0	9,380	238	1.372	78.6	1.10	0.695	5.6
22	35	0.0	C	200	..	...	..	46.1	..	78.0	9,620	228	...	79.6	1.11	0.779	5.9
23	35	0.0	C	1000	..	...	..	46.9	..	83.9	10,320	390	...	81.7	0.94	0.729	5.9
24	35	0.0	D	15	..	...	..	47.3	..	72.2	8,910	233	...	78.6	1.16	0.719	6.0
25	35	0.0	D	50	..	...	..	47.7	42.0	74.6	9,200	234	...	84.1	1.07	0.725	6.2
26	35	0.0	D	200	..	...	..	47.4	..	77.7	9,590	270	...	85.9	1.04	0.757	6.2
27	35	0.0	D	1000	..	...	..	45.4	..	83.6	10,310	364	...	91.0	1.02	0.797	6.2
28	50	0.5	C	50	510	...	0.54	45.0	26.5	86.5	12,490	901	1.431	92.9	0.83	0.813	6.2
29	50	2.0	C	50	365	...	2.04	45.3	29.5	88.4	12,770	1584	1.355	106.4	0.79	0.914	6.8
30	50	5.0	C	50	265	...	3.04	46.3	24.3	91.5	13,210	1959+	1.307	116.6	0.75	0.933	6.9
31	50	0.0	A	15	..	...	..	45.8	..	82.0	11,850	435	...	69.9	1.03	0.703	5.0
32	50	0.0	A	50	..	...	..	46.0	17.5	84.8	12,240	452	...	72.0	0.97	0.707	4.5
33	50	0.0	A	200	..	...	..	45.7	..	84.8	12,240	458	...	74.4	1.02	0.698	4.5
34	50	0.0	A	1000	..	...	..	45.6	..	88.9	12,820	578	...	71.9	0.87	0.700	4.6
35	50	0.0	B	15	..	...	..	45.2	..	83.6	12,080	405	...	69.2	0.97	0.706	4.4
36	50	0.0	B	50	..	...	..	44.3	18.6	84.5	12,220	435	...	71.1	0.93	0.697	4.6
37	50	0.0	B	200	..	...	..	44.9	..	86.3	12,470	464	...	76.2	0.93	0.771	5.3
38	50	0.0	B	1000	..	...	..	44.3	..	88.9	12,820	579	...	74.9	0.80	0.761	4.9
39	50	0.0	C	15	..	...	..	43.8	..	82.7	11,940	390	...	78.1	0.91	0.758	5.7
40	50	0.0	C	50	410	14,450	..	45.6	24.7	84.6	12,220	443	1.250	79.4	0.92	0.757	5.8
41	50	0.0	C	200	..	...	..	42.7	..	85.4	12,320	452	...	80.3	0.95	0.756	5.7
42	50	0.0	C	1000	..	...	..	43.0	..	88.4	12,780	613	...	84.7	0.76	0.798	6.2
43	50	0.0	D	15	..	..	..	45.0	..	83.0	11,990	399	...	84.0	0.92	0.827	6.5
44	50	0.0	D	50	..	...	..	45.0	26.9	85.1	12,300	438	...	85.6	0.89	0.784	5.8
45	50	0.0	D	200	..	...	..	45.0	..	85.4	12,320	435	...	88.2	0.85	0.820	6.1
46	50	0.0	D	1000	..	...	..	44.6	..	88.2	12,730	567	...	89.5	0.78	0.812	5.9
47	65	0.0	C	50	320	16,160	..	41.0	20.2	87.2	14,090	616	1.280	80.5	0.84	0.790	6.0
48	65	0.5	C	50	380	...	0.80	41.2	23.9	88.4	14,280	1041	1.267	86.2	0.75	0.840	6.1
49	65	2.0	C	50	285	...	1.68	42.8	23.0	90.1	14,560	1773	1.213	107.9	0.72	0.799	5.7
50	65	5.0	C	50	225	...	3.37	48.5	19.2	92.7	14,810	1938+	1.181	112.2	0.70	0.963	7.1

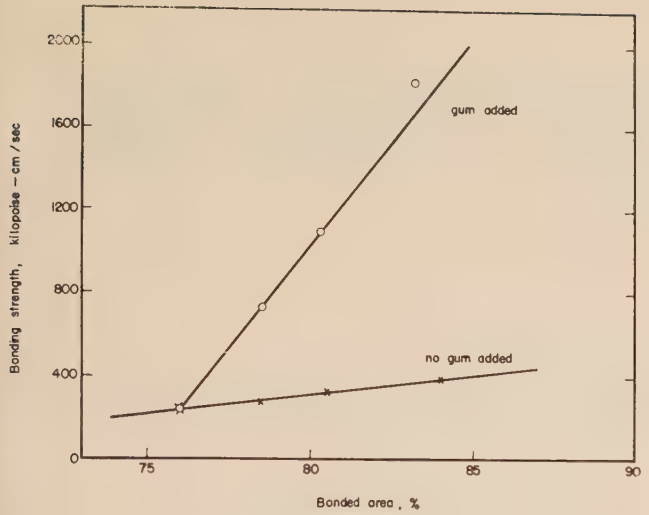

Fig. 9. Bonding strength-bonded area relationship—35 min.

in elongation. The changes involved are seen to be more a result of an improvement in formation than an increase in bonded area.

There was no method available for controlling and varying the bonding strength as formation and bonded area were controlled and varied. Therefore, a comparison was made of the bonding strength of sheets with and without locust bean gum added. The comparison was made at the same value of formation and bonded area so that the effect of the gum upon the bonding strength could be isolated from the effects of changes in bonded area and formation.

Figures 8 and 9 show that locust bean gum produces an enormous increase in bonding strength beyond that which can be attributed to any improvement in formation and increase in bonded area. The data shown in these diagrams present concrete evidence that locust bean gum brings about major increases in the strength of the bonds.

It may at first appear difficult to understand why locust bean gum did not produce greater increases in the strength properties in view of the enormous increases in bonding strength. However, it is to be pointed out that the strength properties do not continue to increase linearly with increasing bonding strength. At higher values of the strength properties the increase becomes quite gradual with increasing bonding strength and approaches the rate of increase found when locust bean gum is used. It is felt that, at the higher values of the strength properties, the strength of the individual fiber becomes much more important.

In summary, it has been demonstrated that locust bean gum increases paper strength by improving formation, by increasing the bonded area, and by increasing the bonding strength. The increase in bonding strength is seen to be the greatest effect. From the relative slopes of lines obtained by complete analysis of the data, the increases in strength properties have been estimated to be approximately as follows:

Strength increase due to	*Contribution, %*
Increased bonded area	15
Improved formation	25
Increased bonding strength	60
Increased fiber strength	0

The increased bonding strength may be due to one of several factors. If there is truly an increase in the strength of the individual bonds, then it is probable that this strength increase is brought about by the formation of bonds involving the gum molecules. Such bonds would indeed be more flexible than bonds between two cellulose molecules which are rigidly held in the crystalline structure of the fibers. As was mentioned earlier, a similar effect might be present in the case of hemicelluloses.

The remaining possibility is that the optical technique does not give a true measure of the bonded area because of the difference in distances involved for optical contact and hydrogen bonding. That is, there may be more bonds per unit bonded area (as measured by the optical method) when locust bean gum is present. It is felt that a gas adsorption method of measuring surface area (and, consequently, bonded and unbonded areas) would reveal whether or not such a condition exists because the distances involved with gas adsorption techniques are more nearly of the same order of magnitude as the distances involved in hydrogen bonding. The possibilities of using such a method for measurement of surface area of fibers are now being studied by Haselton (*23*).

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Problems Concerning the Sulphur in Sulphate Pulping

TERJE ENKVIST

Solid thiolignins with high contents of sulphur are slowly formed in sprucewood by hydrosulphide ions or, with almost the same result, by thiosulphate ions at pH 7 and 100°C., and possibly also in the first stages of a common sulphate digestion. During the later stages of sulphate cooking the thiolignins are dissolved, they split off sulphur and are gradually changed to common sulphate lignin containing only about 2% sulphur. The main portion of this remaining sulphur can be removed by heating the sulphate lignin in alkaline solution with Raney nickel or zinc powder. Thiocarbonyl or dialkyl monosulphide sulphur does not seem to be present in sulphate lignin in any considerable amounts. Experiments with model substances for lignin seem to show that phenyl carbinol groups or the corresponding dialkyl ethers can easily react with hydrosulphide ions, but only if the benzene nucleus contains an activating free phenolic hydroxy group. Such a group can be set free at the sulphate digestion by influence of hydroxyl ions on phenolic ether bonds.

HYDROGEN SULPHIDE LIGNIN

STARTING from observations made by Hägglund and Ringström (*2*) it was found that if wood is digested with a solution of hydrogen sulphide or sodium hydrosulphide, without sodium hydroxide, at pH from 7 to 8.5, then part of the lignin is sulphidized but remains undissolved in the wood (*3*, *7*). If this sulphidized wood is heated to 160°C. or higher, the sulphidized lignin melts and flows in the fibers, finally filling up their lumens completely (*4*). The sulphidized wood cannot be pulped further with a common acid sulphite digestion (*5*); it can, however, be delignified, as in the case of pine heartwood (*6*), by digesting with sodium sulphite solutions first at pH 5.5 and thereafter at pH about 2.

The sulphidized lignin can be extracted from the sulphidized wood with sodium hydroxide solution or with pyridine at 100°C. or still lower temperatures, and also with such neutral, organic solvents as dioxane or 75% alcohol. The sulphidation and subsequent dissolution of the thiolignin can be repeated, and in this way after eight subsequent sulphidations and extractions at pH 7 and 100°C. about 60% of the lignin of the wood can be removed (*1*, *3*). The process cannot be considerably accelerated by grinding of the wood in a colloid mill or by pretreating it with dilute acids, alkaline solutions, chlorine, or swelling agents like calcium thiocyanate solution (*4*). Thus the slowness of the sulphidation reaction at 100°C. seems to be due not to any membranes or other topochemical obstacles in the wood, but to a chemical reaction which goes very slowly under the conditions used.

The thiolignin which is formed at sulphidation of wood at pH 7 and 100°C. and dissolved by treatment with solvents has been called hydrogen sulphide lignin, although it seems in fact to be the hydrosulphide ion and not the undissociated hydrogen sulphide that is the main reagent (*4*).

THIOSULPHATE LIGNIN

If sprucewood is heated with a neutral sodium thiosulphate solution at 100°C. about the same result is obtained as with buffered sodium hydrosulphide solution at pH 7 (*8*). The thiolignin formed can be dissolved from the wood with 75% ethanol and its contents of carbon, hydrogen, total and disulphide sulphur, and methoxy groups as well as its ultraviolet spectrum and equivalent weight are very like those of hydrogen sulphide lignin. The thiosulphate perhaps reacts in a way which in some respects resembles the formation and further reforming of Bunte salts (*9*) from alkyl halogenides, e.g.,

$$C_2H_5Br + Na_2S_2O_3 \rightarrow C_2H_5S_2O_3Na + NaBr$$
$$C_2H_5S_2O_3Na + H_2O \rightarrow C_2H_5SH + NaHSO_4$$

In lignin, the part of the halogen in this scheme is taken by a reactive group such as a phenyl carbinol or phenyl carbinol ether group.

In fact, a considerable amount of sulphate ion is formed during digestion of wood with sodium thiosulphate solution.

This formation of a thiolignin through the influence of sodium thiosulphate is of some importance because analyses of various black liquors carried out by Camilla Juslén at the University of Helsingfors have shown that large amounts of thiosulphate ions are formed during sulphate digestions. These thiosulphate ions then probably form thiolignins in about the same manner as hydrosulphide ions (compare (*10*)).

SPLITTING OFF OF SULPHUR FROM THIOLIGNINS

The hydrogen sulphide lignin contains varying, but large amounts of organic sulphur, up to 21%. With heating in presence of alkali it is gradually changed. Heating in alkaline solution at 80°C. changes its ultraviolet absorption spectrum irreversibly so that it becomes very similar to that of common sulphate lignin (*12*).

The following scheme gives a rough picture of the changes of the thiolignins based on analyses carried out (*3*, *11*):

The composition of the lignin in sprucewood is assumed to correspond roughly to the formula $(C_{10}H_{11}O_{3\frac{1}{2}})_n$. For instance, at pH 7 and 100°C., under the influence of hydrosulphide or thiosulphate ions, lignin adds the elements of hydrogen sulphide, giving the thiolignin I, which can have very varying contents of organic sulphur, up to 21%; the main fraction is here

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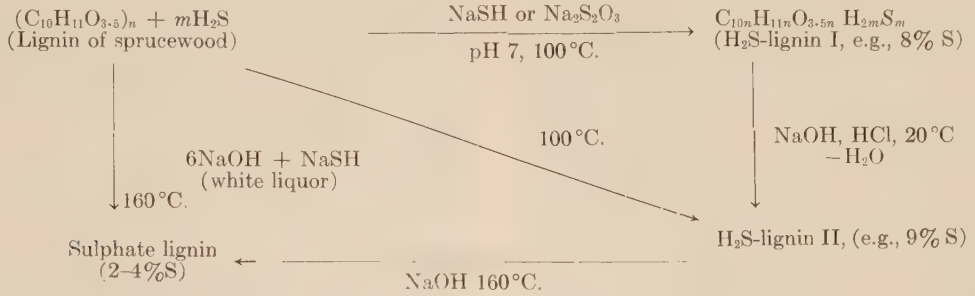
assumed to contain 9% organic sulphur (compare (*12*), Table III). This thiolignin rich in sulphur, in contrast to other lignins, cannot be further methylated with methanol and hydrochloric acid (*3*). It seems to contain a rather small amount of phenolic hydroxy groups, roughly one for each three phenyl propane units (*12*).

By simply dissolving in sodium hydroxide solution at room temperature and thereafter precipitating with, for instance, hydrochloric acid, the hydrogen sulphide



lignin I loses water and the sulphur content goes up, e.g., to about 9% ((*12*), Table III). This lignin is called hydrogen sulphide lignin II. It is in many respects like the lignin obtained from a sulphate digestion at 100°C. With strong heating of this hydrogen sulphide lignin II in sodium hydroxide solution, for instance at 160°C., the lignin loses hydrogen sulphide and gives a thiolignin with something between 2 and 4% of organic sulphur, phenolic hydroxy groups are set free and—as shown by spectroscopic evidence—the lignin becomes very similar to the common sulphate lignin obtained with sulphate digestions at, e.g., 160°C. This seems to contain a phenolic hydroxy group in almost every phenyl propane unit (*12*).

Here it may be added that the sulphur content is not the same in all parts of the common sulphate lignin. The low molecular, dialyzable part of it contains about 4%, the main fraction, which is not dialyzable, only about 2% (*13*).

Experiments carried out with L. Andersen and P. Halmekoski in Helsingfors (*28*) have shown that the main portion of the sulphur in the common sulphate lignin can be removed by heating with Raney nickel and also with zinc powder in alkaline solution at about 100°C.

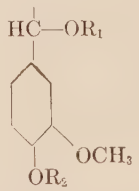
The related facts show that it is possible and perhaps probable that the sulphur compounds of the digesting liquor in the common sulphate digestion react first to form a thiolignin with a rather high content of sulphur. Then, during the continued heating a good deal of the sulphur is split off under the influence of hydroxyl ions, forming new hydrosulphide or thiosulphate ions. These can then react with new amounts of lignin in the wood. The whole reaction seems to be a cyclic process, a kind of catalysis, with hydrosulphide and thiosulphate ions as catalysts. The 2% of sulphur in the ordinary sulphate lignin would then be only a small fraction remaining of the original larger amount of sulphur introduced in the lignin, and probably changed by secondary reactions during the digestion into some form which is stable against the influence of alkali.

This assumption of a catalytic action of the sulphur compounds at the sulphate digestion is supported by two further facts, namely:

1. A sulphur content of about 5% or somewhat more than one sulphur atom in every group of four phenyl propane units is a minimum required for delignification of wood in neutral or almost neutral solution through the formation of thiolignins and their dissolution by lye or neutral solvents (*3*).
2. The consumption of inorganic sulphur during a sulphate cook is small compared with the consumption of sodium hydroxide (*14*).

ACTIVATION OF THIOLIGNIN FORMATION BY FREE PHENOLIC HYDROXY GROUPS

Together with Mauri Moilanen of the Swedish Forest Products Research Laboratory, a series of sodium hydrosulphide digestions of model substances of lignin was carried out at 100°C. and in neutral or only slightly alkaline solutions, thus at the same conditions where sprucewood is sulphidized under formation of hydrogen sulphide lignin I (*15*, *16*). A considerable uptake of sulphur was observed in the cases of saligenin, vanillyl alcohol, xylenol alcohol and its ether as well as pinoresinol, whereas a number of other substances, among them isoeugenol, acetoguaiacone, several γ-pyrones, chalkone derivatives, flavanones and glucosides as well as veratryl alcohol, veratryl ether, glycerol monoguaiacyl ether and dihydro-dehydro-di-isoeugenol did not show any substantial uptake of sulphur (compare also (*17*, *18*, *19*)). These results make it seem probable that only the oxy-benzyl alcohol or oxy-benzyl ether type I—where R_1 can be H or an alkyl group but R_2 must be H—can be sulphidized at the same conditions as sprucewood.



(I)

Thus, the model experiments give some support to the assumptions of Adler (*20*) and Lindgren (*21*), who, starting from observations made by Holmberg (*22*), propose that there are benzyl alkyl ether crosslinkings in lignin, in addition to phenol ether bonds. Hydrosulphide ions can react very easily with such crosslinkings, even in neutral solution at 100°C., and also with the corresponding benzyl alcohol groups (R_1 = H), but only if the adjacent benzene nucleus

carries a *free* phenolic hydroxy group (R_2 = H). If the phenolic group is bound, as for instance a phenyl alkyl ether (R_2 = alkyl) or by formation of a heterocyclic ring, as in dihydro-dehydro-di-isoeugenol, then the benzyl alcohol or benzyl alkyl ether group will not be sulphidized. In contrast, phenol ether bonds can be opened by heating with sodium hydroxide solution (*23*). Thus, it seems that in case of such groups in lignin (R_2 = alkyl), where there is no activating free phenolic hydroxy group in the adjacent benzene nucleus, the hydroxyl ions must first split the phenol ether bonds and set the phenol hydroxy group free, and only thereafter can the hydrosulphide ions split the adjacent benzyl alkyl ether bond. In neutral solution the splitting of the phenol ether bonds is slow, and this would explain the slowness of the sulphidation of lignin at pH 7. In the sulphate digestion, it seems to be necessary to have two reagents to open the two kinds of linkages: the hydroxyl ions to open the phenolic ether bonds and the hydrosulphide ions to open the crosslinkages which possibly are benzyl alkyl ether bonds.

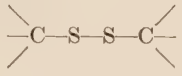
After the formation of free phenolic hydroxy groups the 5-positions will be very reactive and condensation seems to occur here, splitting off water and forming new carbon bridges between the benzene nuclei (*24*). Because most of the ether bonds have been opened, the final result is, however, that the lignin is split into fragments with molecular weights from several hundred to several thousand (*3*, *7*, *27*), which are sufficiently small to be dissolved in the digesting liquor.

THE NATURE OF THE SULPHUR IN THE THIOLIGNINS

During further work to study these hypotheses, Camilla Juslén in Helsingfors titrated lignin isolated in a nitrogen atmosphere after a sulphate digestion of sprucewood at 100°C. and found 1.3% of mercaptane sulphur in addition to about 0.6% of disulphide sulphur. This and other results make it seem probable that the first stage in the reaction of hydrosulphide ion with the lignin of the wood is a formation of mercapto ions or groups, e.g., according to the scheme:

$$R.O.R_1 + SH^- \rightarrow RS^- + R_1OH$$

These mercapto groups are very easily dehydrogenated to disulphide groups

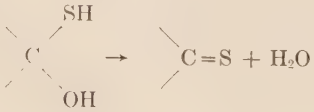


This is shown by the fact that isolated hydrogen sulphide lignins prepared at 100°C. and pH 7 seem to contain up to 7% of disulphide sulphur. Titrations show that after sulphate digestions—and generally after digestions in strongly alkaline solutions—there are only traces left of the disulphide and also of the mercapto groups.

It would be natural to suppose that the mercapto groups give sulphide groups according to the scheme:

$$R_1OH + R_2SH \rightarrow R_1—S—R_2 + H_2O$$

Another possibility would be a formation of thiocarbonyl according to the formula:



Thiocarbonyl groups are assumed to split off hydrogen sulphide at treatment with hydroxylamine (*25*). Qualitatively, sulphate lignin and sodium hydrosulphide lignin from a two-stage digestion of wood first with hydrosulphide and then with hydroxide (*3*) were in fact found to split off some hydrogen sulphide at heating with hydroxylamine solution; hydrogen sulphide lignin gave a much weaker reaction. A quantitative determination gave as a result an amount of hydrogen sulphide corresponding to not more than 0.3% of thiocarbonyl sulphur in a sulphate lignin containing a total of about 2% of organic sulphur.

Aliphatic dialkylsulphides should add methyl iodide under formation of alkyl sulphonium iodide. Experiments with sulphate lignin showed, however, that there was almost no uptake of iodide during boiling of the lignin with methyl iodide in acetone solution (compare (*25*)).

There remains among other things the possibility that the sulphur in sulphate lignin would be bound in diaryl or aryl alkyl sulphides, which do not add methyl iodide (*26*), or in heterocyclic sulphur compounds as, for instance, thiophene or thionaphthene derivatives.

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Photometric Determination of the Solubility of Pulp in Sodium Hydroxide Solutions

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A photometric procedure for determining the solubility of pulps in sodium hydroxide solutions was found to be convenient, rapid, and at least equal in precision to the gravimetric procedure for determining beta-cellulose. Comparison of results obtained by this method on a number of purified pulps indicates that the amount of alkali-soluble material and the relative proportion of the fraction that precipitates on acidifying the extract are dependent on the history of the pulps.

IT HAS been widely recognized that the solubility of cellulosic materials in sodium hydroxide solutions has practical significance. For example, the solubility of wood in a boiling 1% solution of sodium hydroxide increases with increasing decay of the wood, which, in turn, results in a decrease in yield of pulp. These facts are the basis for a test useful in wood pulp production. In addition, the proportion of pulp insoluble in strong solutions of sodium hydroxide has been related to the permanence of paper and is used in specifications for wood pulps intended for chemical conversion.

Recently, in an article on the importance to the viscose industry of the alkali solubility of pulps (*1*), it was stated that the hemicellulose which is soluble in a 10% solution of sodium hydroxide and which persists in the filament is essential to the quality of rayon tire cord. It was further stated that this portion could be estimated satisfactorily by the difference between the solubilities of the pulp in 10 and 18% solutions of sodium hydroxide.

The possible significance of this difference in solubility was also speculated upon recently in the report of a rather extensive study of the alkali solubility of pulp (*1*). The carbohydrate material dissolved was determined by the Swedish Standard CCA8, which involves oxidation with dichromate and the volumetric determination of unconsumed dichromate.

For several years at the Forest Products Laboratory determinations have been made of the solubility of purified pulps in a 7.14% solution of sodium hydroxide at 100°C. and of the solubility of both purified pulps and paper-making pulps under the conditions of TAPPI Standard T 203 m-44. Recently, it has been undertaken to determine the solubility of these types of pulp in 10 and 18% solutions of sodium hydroxide and the proportions of acid-soluble and acid-insoluble fractions in the extracts. As these data accumulate, it should be possible to assay their worth as measures of the effects of variables in pulping, bleaching, and purification, and their correlation, if any, with the properties of end products.

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The procedure being used for these determinations was adopted, with only minor variations, from the photometric method of Ohlsson (*3*) which comprises (1) extracting with the alkaline solution, (2) oxidizing an aliquot of the extract with potassium dichromate in sulphuric acid, and (3) measuring the light absorption of the chromic ions produced by the oxidation. The article referred to, which is written in English, gives the details of the development of the method, sample preparation, measurement of transmittancy (light absorption), and the effect of variables in the alkaline treatment and in the dichromate oxidation.

The definitions of beta and gamma-cellulose given by previous investigators (*2*, *3*) are adopted here. Beta-cellulose is that fraction of sodium hydroxide-soluble material which is precipitated upon acidifying the extract to pH 6, irrespective of the concentration of the alkali in the original solution. Gamma-cellulose is the fraction that remains in solution in the acidified extract.

EXPERIMENTAL DETAILS

The photometric method was applied to a series of purified pulps. For comparison, these pulps were also analyzed for alpha-cellulose content according to TAPPI Standard T 203 m-44, modified by omitting the mechanical "fluffing" of the pulps. Beta-cellulose was determined gravimetrically, and gamma-cellulose was calculated by subtracting the sum of alpha and beta-cellulose, ether solubles, and ash from 100.

Photometric Method

Special Equipment. The special equipment for the photometric method comprises (1) a spectrophotometer or a filter-photometer with a filter having a transmission peak in the range of 590 to 610 mmu, (2) photometer cells of 1-cm. light path, and (3) a centrifuge with 100-ml. bottles.

Reagents. The reagents required are: sodium hydroxide solutions, 18% (215.5 grams per liter) and 10% (110.9 grams per liter); dilute sulphuric acid, approximately 7.0 normal; potassium dichromate, 1 normal (49.035 grams per liter); concentrated sulphuric acid; pure anhydrous glucose for calibration, 2 grams dissolved in water and diluted to 100 ml; Methyl Red indicator, 1 gram per 100 ml. of 95% ethyl alcohol.

Development of Calibration Curve. A calibration curve is developed as follows: titrate 20 ml. of the alkali to be used for the solubility determination with approximately 7.0 normal sulphuric acid using the Methyl Red indicator (pH approximately 6). Pipet 20-ml. portions of the alkali into 200-ml. volumetric flasks and, without the indicator, add exactly the same amount of 7.0 normal sulphuric acid found by titra-

tion. Add 0, 2, 4, and 6 ml. (0, 40, 80, and 120 mg. of glucose) of the glucose solution to the separate portions of acidified solutions. Add 25 ml. of 1 normal potassium dichromate to each solution and dilute to a total volume of 75 ml. Add 100 ml. of concentrated sulphuric acid to each solution while whirling the flask. Allow the solutions to stand 15 min., then cool and dilute to 200 ml.

Determine the transmittancy of the solution using the specified light filter and a 1-cm. absorption cell, with water for the reference standard. Construct a calibration curve on semilogarithmic graph paper relating the weight of soluble carbohydrate to transmission. This soluble carbohydrate is considered to be hemicellulose plus degraded cellulose, and the weight of it is 0.9 of the weight of glucose. For convenience, the soluble carbohydrate is hereafter termed beta and gamma-cellulose.

Sodium Hydroxide Extraction

For the alkali extraction, tear pulp into small pieces by hand. Weigh an amount equal to 2 grams of moisture-free pulp in a beaker or a weighing bottle. Pipet 100 ml. of sodium hydroxide solution into a 4 or 6-oz. glass-stoppered bottle and cool to 23°C. Add the pulp and shake 5 min., using glass beads if necessary to disperse lumps of fibers. Place the bottle in a water batch maintained at 25°C. After 1 hr., filter the liquor through a Gooch or coarse fritted-glass crucible with gentle suction. Refilter the liquor without drawing air through the mat of fibers.

Pipet 20 ml. of the liquor into a 200-ml. flask for determination of beta and gamma-cellulose and another 40 ml. into a 100-ml. flask for precipitation of beta-cellulose, that is, the acid-insoluble fraction. Titrate 10 or 20 ml. of the remaining liquor with approximately 7.0 normal sulphuric acid using Methyl Red indicator.

Acidify the 20-ml. portion without any indicator by using the amount of acid calculated from the titration. Oxidize the solution and measure its transmittancy as described for the calibration curve. Obtain the weight of alkali solubles, in grams, from the curve and calculate the percentage of total alkali solubles using the equation:

$$\text{Per cent of beta plus gamma-cellulose} = \frac{\text{weight} \times 100 \times 5}{2}$$

Acidify the 40-ml. portion of the liquor to about pH 6 in the same manner as for the 20-ml. portion and shake vigorously. Allow the solution to stand for several hours at room temperature or if necessary freeze the solution for coagulation of beta-cellulose. When the mixture is finally at room temperature, dilute to 100 ml. Separate the precipitate by centrifuging, and pipet 50 ml. of clear liquor into a 200-ml. flask. Oxidize the solution with dichromate and concentrated sulphuric acid and measure the transmittancy as described previously.

The weight of the gamma-cellulose is obtained from the curve and calculated as a percentage by the following equation:

$$\text{Per cent of gamma-cellulose} = \frac{\text{weight} \times 100 \times 5}{2}$$

The percentage of beta-cellulose is the difference between the percentages of total alkali solubles and gamma-cellulose.

RESULTS

The solubilities of a number of purified pulps in 10 and 18% solutions of sodium hydroxide as measured by the photometric method are given in Table I. Values obtained with the gravimetric procedure are also included in this table.

The differences between the total solubilities in 10 and 18% sodium hydroxide determined by the photometric method and the total solubles determined by the gravimetric procedure do not appear to be large

Table I. Solubility of Purified Pulps in Sodium Hydroxide Solutions

	Photometric procedure[a]						*Gravimetric procedure*[b]			
	Soluble in 18% sodium hydroxide			*Soluble in 10% sodium hydroxide*						
Pulp no.	*Beta-cellulose, %*	*Gamma-cellulose, %*	*Total alkali-soluble material, %*	*Beta-cellulose, %*	*Gamma-cellulose, %*	*Total alkali-soluble material, %*	*Alpha-cellulose, %*	*Beta-cellulose, %*	*Gamma-cellulose, %*	*Total alkali-soluble material, %*
2717	4.6	0.8	5.4	6.7	0.9	7.6	90.6	0.8	8.0	8.8
2720	1.3	0.4	1.7	2.3	0.2	2.5	96.4	0.5	2.5	3.0
2748	6.2	1.0	7.2	7.8	1.0	8.8	89.4	0.3	9.8	10.1
2749	3.8	0.6	4.4	4.9	0.5	5.4	94.0	0.2	5.0	5.2
2740	3.7	1.1	4.8	4.6	1.1	5.7	94.8	0.2	4.2	4.4
2741	2.4	0.6	3.0	3.0	0.4	3.4	96.6	0.3	2.4	2.7
2727	3.5	0.6	3.1	4.9	0.4	5.3	94.3	0.1	5.2	5.3
2729	2.4	0.6	3.0	3.6	0.3	3.9	96.0	0.1	3.4	3.5
2742	3.8	0.7	4.5	4.8	0.5	5.3	95.0	0.5	4.1	4.6
2743	2.8	0.4	3.2	3.7	0.3	4.0	96.1	0.2	3.2	3.4
2736	2.6	0.6	3.2	3.7	0.3	4.0	96.5	0.1	3.1	3.2
2737	1.7	0.5	2.2	3.1	0.2	3.3	97.2	0.1	2.4	2.5
2723	2.3	0.7	3.0	4.5	0.3	4.8	95.9	0.2	3.4	3.6
2725	1.9	0.6	2.5	3.7	0.1	3.8	97.1	0.1	2.4	2.5
2732	2.8	0.4	3.2	4.1	0.3	4.4	96.2	0.6	2.6	3.2
2733	1.9	0.4	2.3	3.6	0.1	3.7	96.5	0.6	2.5	3.1
2753	2.3	0.6	2.9	3.0	0.8	3.8	96.4	1.8	1.6	3.4
2754	1.4	0.6	2.0	2.6	0.3	2.9	97.1	1.6	1.0	2.6
2744	1.9	0.8	2.7	3.3	0.4	3.7	96.9	0.1	2.6	2.7
2745	1.5	0.6	2.1	2.9	0.3	3.2	97.4	0.2	2.0	2.2
2761	1.6	0.6	2.2	4.2	0.3	4.5	96.9	2.3	0.4	2.7
2762	1.2	0.4	1.6	3.9	0.1	4.0	96.9	2.3	0.3	2.6

[a] The total and acid-soluble fractions (gamma-cellulose) of alkali-soluble material were determined directly, and the acid-insoluble fraction (beta-cellulose) was obtained by difference.

[b] The alpha-cellulose was determined by TAPPI Standard T 203 m-44, modified by omitting the mechanical fluffing of the pulp; beta-cellulose by filtering and weighing the precipitate from the acidified extract (pH 4), and gamma-cellulose by subtracting the sum of alpha and beta-cellulose ash, and ether solubles from 100.

when the differences in the extraction treatments are considered. Therefore, it is not likely that there is any large error in the total solubilities obtained by the photometric method. The proportions of beta and gamma-cellulose obtained by the photometric method, however, are almost the reverse of the proportions of these fractions obtained by the gravimetric procedure except in the case of pulps 2761 and 2762. A possible explanation of this difference is that some of the beta-cellulose, depending on conditions and treatment used in preparing the pulps, is redissolved during the washing step in the gravimetric procedure.

As may be expected from reports in the literature, the total solubility and the beta-cellulose fraction for 10% sodium hydroxide are generally higher than those for 18% sodium hydroxide, and there is slightly more gamma-cellulose in the 18% than in the 10% solution. The high amount of beta-cellulose dissolved by 18% sodium hydroxide, and the slight difference in the amounts of gamma-cellulose dissolved by 10 and 18% solutions of sodium hydroxide are not in accord with the conclusions of others (*2*) as follows: "The solubility of beta-cellulose in 18% NaOH is very small. The total solubility in 18% NaOH is thus a measure of the gamma-cellulose content, and the difference between the solubilities in 10 and 18% NaOH is an approximate measure of the beta-cellulose content." This non-agreement may be due to differences in the methods used, differences in the pulps, or both.

CONCLUSIONS

The oxidation-photometric method for measuring the carbohydrate fractions of bleached and purified pulps soluble in sodium hydroxide solutions is convenient, rapid, and at least equal in precision to the gravimetric procedure.

The values of beta and gamma-cellulose found with this method may be more accurate than those found by the gravimetric procedure.

Calculated values for the fraction of the purified pulps insoluble in 18% sodium hydroxide solution agree closely with alpha-cellulose values determined gravimetrically. Consequently, it may be advantageous to obtain values for alpha-cellulose indirectly by this method and avoid the controversial features of present gravimetric procedures.

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Sulphite Spent Liquor IV

Ammonia Recovery from Ammonium Sulphite Spent Liquor by Ion Exchange Processes

AARON E. MARKHAM and JOSEPH L. McCARTHY

The absorption of ammonium ions from ammonium sulphite spent liquor onto the ion exchange resin Dowex 50, and also the stripping of these ions from the resin by use of sulphurous acid solutions has been investigated. Eleven cycles of exchange were carried out batchwise in an apparatus which consisted of six fixed bed columns. Operating conditions, analytical results, and material balances for the several cycles are reported. About 60 or 65% recovery of ammonium ion was obtained under the conditions used.

The need exists for economic methods of processing sulphite spent liquors so that the discharge of these liquors into water courses can be avoided and the dissolved organic and inorganic compounds can be conserved and utilized. While research and development work is leading to the conversion of considerable amounts of these solutes into alcohol, yeast, and other salable products, this type of development occurs relatively slowly. Thus the best prospects for finding economically feasible and generally applicable methods for processing sulphite spent liquor seem to exist in the type of processes wherein the liquor is evaporated and burned to yield useful steam and also process chemicals in a form suitable for reuse.

Attempts to treat calcium sulphite spent liquor in this way have shown that: (1) the solubility relationships within a digester limit total solids concentration in calcium sulphite spent liquor to around 12% so relatively large amounts of steam are required for evaporation compared with evaporation of liquors prepared using the more soluble bases as the cation; (2) scale tends to form on heat exchange surfaces in the evaporation of calcium sulphite spent liquor and special equipment or processes must be employed to deal with this situation; (3) special furnace and boiler systems are probably required to permit calcium sulphite spent liquor burning and heat recovery to be executed effectively; and (4) recovery from a furnace of calcium and sulphur in forms suitable for reuse in the process cycle is not readily accomplished.

The possibility of operating a sodium-base sulphite pulping process with a cyclic process for recovery of heat and process chemicals has been investigated in the United States and in Scandinavia, and it is understood that a commercial plant is now operating in the latter region. This process for recovery and re-use of sodium and sulphur seems to be complex (*1*) and would

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apparently require major capital outlay for installation, and also careful control for satisfactory performance. However, considerable study and experimentation on this type of process have been done in this laboratory, and it is expected that this work will be reported later.

An alternative approach has been taken by Tomlinson (*2*) and Hatch (*3*) who showed that the liquor from magnesium-base sulphite pulping could be evaporated and burned in a specially designed furnace to yield process steam, magnesium oxide, and also sulphur dioxide which is recovered from the stack gas stream by absorption into an aqueous suspension of the magnesium oxide. Although a rather complete rebuilding of the usual furnace boiler systems and other major capital outlays are required for installation of the magnesium cycle, the recovery of process chemicals and steam, together with the relatively high initial total solids concentration attainable in the liquor, brings the magnesium process into major prominence as one approach to the solution of the problem at hand. An installation is being operated at Longview, Wash., (*4*) by the Weyerhaeuser Timber Co., and another at Ketchikan, Alaska, is being built by the Puget Sound Pulp & Timber Co. (*5*).

Still another approach under investigation is the treating of liquor from ammonia-base sulphite pulping which is of interest because: (1) Douglas-fir and other species of woods can be pumped by the ammonium base but not by the calcium-base sulphite pulping process so that better utilization of forest holdings might be made; (2) the time required for pulping can apparently be decreased because of the higher diffusivity of the ammonium ion versus the calcium ion; (3) the relatively high solubility of ammonium salts makes it possible to obtain from the digester liquors quite high in total solids content so that the steam required for evaporation is minimized; (4) evaporator scale formation is greatly reduced compared with the calcium liquor behavior; (5) concentrated ammonium liquor can apparently be burned to yield steam in existing furnace-boiler installations without major revision; (6) no substantial ash results from the operations so no special cyclone is necessary to avoid the scattering of dust over the environs of a plant; and (7) most sulphur in the liquor entering a furnace should appear in the stack gas as recoverable sulphur dioxide as indicated by experiments conducted in this laboratory and also by large-scale tests (*6*).

In our experiments, ammonium sulphite spent liquor solids containing 2.05% sulphated ash were burned in a stream of air at known temperatures. Using an iron combustion tube, it was first found that major proportions of sulphur trioxide were formed as indicated in Table I. However, in later experiments conducted at somewhat higher temperatures in a ceramic tube and especially with rapid cooling of product gas, it became evident that sulphur dioxide recovery could be of the order of 90 or 95% of the sulphur fed and that ammonium sulphite spent liquor processing could probably be conducted to permit recovery of both heat and sulphur dioxide.

For recovery of ammonia as well as heat and sulphur dioxide, it is possible to displace ammonia from the liquor by use of a stronger base. The use of lime has been considered, for example by Hausen (*7*), but various studies including work in this laboratory on combustion of "limed" sulphite spent liquor to recover heat and also sulphur and lime for reuse have indicated that this is economically difficult to accomplish. The use of magnesium oxide has been proposed by Helleur (*8*), and here the resultant magnesium sulphite spent liquor presumably would be processed by the Tomlinson-Hatch-type cycle.

It has also been proposed that ammonia be recovered from ammonium sulphite spent liquor by pyrolysis of the solids (*9*). However, study in this laboratory led to the conclusion that satisfactory ammonia recovery can be obtained only under conditions which would not permit economic recovery of heat and sulphur dioxide (*10*).

Another method which can be considered for cation recovery from sulphite waste liquor is based on the use of ion exchange resins. As applied for ammonia recovery, the process may be as follows: (1) passage of concentrated ammonium sulphite spent liquor through a cation exchange resin to remove ammonia from the liquor and affix it on the resin, (2) burning of the resultant liquor to yield process steam with possible recovery of sulphur dioxide by absorption from the stack gas to provide sulphurous acid or a bisulphite solution, and (3) passing of a sulphurous acid solution through the cation exchange resin to regenerate the resin by removing ammonia into the sulphurous acid and thereby provide an ammonium bisulphite solution suitable for process re-use.

This type of process has now been in part investigated by carrying out experiments concerned with absorption of ammonium ion from an ammonium sulphite spent liquor onto a cation exchange resin retained in a series of six fixed bed columns, and with stripping of ammonium ion from the resin into a sulphurous acid solution. Practical results obtained are reported in several tabulations and graphs. Broader discussion of this type of process will be submitted later with respect to ion exchange resin equilibria and to cost influences.

EXPERIMENTAL

Reagents and Materials

Sulphite Spent Liquors. The sulphite spent liquor used in this investigation was kindly provided by W. W.

Table I. Recovery of Sulphur Oxides from Combustion of Ammonium Sulphite Spent Liquor Solids

Expt.	Temperature, °C.	Recovery[a] SO_2, %	Recovery[a] SO_3, %	Recovery[a] Total, %
27E	925	40	47[b]	87
27G	975	39	47[b]	86
29	860	66	26	92
30A	950	66	20	86
30B	950	62	19	81
30C	950	82	14	96
30D	950	75	13	88
39A	990	96[c]	..	..
39B	925	93[c]	..	
39C	1005	90[c]	..	..
39D	1000	91[c]	..	..

[a] Recovery is expressed as percentage of the original total sulphur. The solids containing 2.05% sulphated ash were burned in a stream of air.
[b] Combustion gases in experiments 27E and 27G were absorbed in an alkaline solution in the absence of glycerol, an oxidation inhibitor which was used in all other experiments.
[c] Combustion in experiments 39A, 39B, 39C, and 39D was carried out in a ceramic "Mullite" tube whereas an iron tube was used in all other experiments.

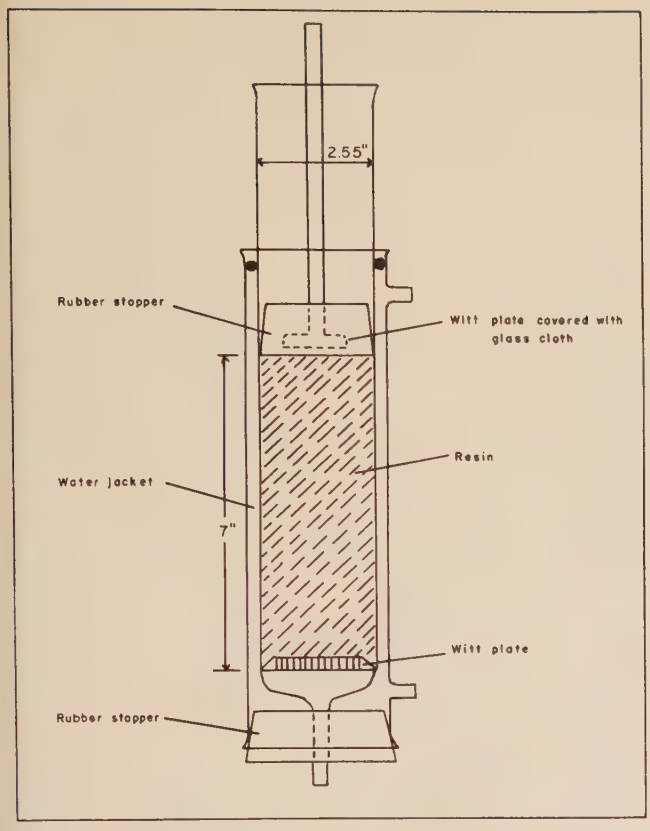

Fig. 1. Detail of ion exchange column

Moyer of the Crown Zellerbach Corp. It was evaporated at atmospheric pressure to about 50% solids, and this solution was designated as liquor-feed. The analyses of the raw material and of the concentrated liquor when first obtained and after storage for about 8 weeks during progress of the exchange experiments were determined with results shown in Table II. The liquor was filtered before use.

During the storage of the concentrated liquor, it was observed that orange-yellow crystals separated in considerable amount. These crystals were obtained to the extent of about 0.07% of the waste liquor solids. Analyses were carried out on the crystals with the following results. Kjeldahl N, 5.92%; OCH_3, 0.21%; CaO, 7.06; Fe, 4.19%; S, 0.077%. The crystals were birefringent under a polarizing microscope. They are apparently organic in nature and may be a mixture.

Table II. Characteristics of Ammonium Sulphite Spent Liquor

Characteristic	*Liquor as recd.,*[a] *Sept. 7, 1950*	*"Liquor feed"* *Oct. 2, 1950*	*"Liquor feed"* *Nov. 24, 1950*
Total solids, g./l.	139.8	574[b]	561
pH	3.2	4.2	3.6
Density, g./ml. (25 °C.)	...	1.201	...
Viscosity, cp. (25 °C.)	...	0.38	...
Methoxyl, OCH_3[c]	6.70	6.98	...
Ammonia, NH_3 (Kjeldahl)[c]	4.16	4.24	4.31
Ammonia NH_3 (alkali)[c]	3.86	3.90	3.76
Reducing substances[c]	17.7	17.3	...
Calcium oxide, CaO[c]	0.185	0.128	0.158
Sulphated ash[c]	1.11	1.24	1.04
Total sulphur S[c]	7.2	6.84	...
Free SO_2[c]	0.18	0.03	..
Loosely comb. SO_2[c]	2.09	1.14	...
Sulphate, SO_3[c]	1.68	1.48	1.68

[a] The authors appreciate the gift of this liquor from W. W. Moyer of the Crown Zellerbach Corp., Camas, Wash.
[b] This total solids concentration amounts to 47.7% total solids by weight.
[c] Results are reported as per cent of total solids.

Table III. Screen Analyses of Ion Exchange Resin Before and After Eleven Process Cycles

Tyler mesh size (in.-l.)	*Hole size, mm.*	*Resin increment retained* *Before use, %*	*Resin increment retained* *After use, %*
14	1.168	0.52	0.85
20	0.833	24.9	27.4
28	0.586	42.7	41.4
35	0.417	21.5	21.5
48	0.295	7.3	6.7
65	0.208	2.4	2.0
Through		0.63	0.54

They dissolve in acids and ammonium hydroxide but do not reprecipitate. The crystalline material is not a simple ammonium salt.

Sulphurous Acid Stripping Solution. The regenerant or stripping solution was made by dissolving bottled SO_2 in water, and diluting to a concentration of 30.5 to 33.5 grams SO_2 per liter. This solution was called acid feed.

Resin. The resin used was Dowex 50-8X, a sulphonated polystyrene-type cation exchanger manufactured by the Dow Chemical Co. and supplied through the courtesy of Fred R. Armbruster. Particle size distribution was determined for the resin as first obtained and then after the experiments were completed, and results are given in Table III and plotted in Fig. 3.

Analytical Methods

The methods used for analyses were generally those described previously (*11*). The viscosity was determined at one flow rate only in an Ostwald-type viscometer, using water as a reference liquid.

"Alkali ammonia" was determined by distilling the ammonia from the sulphite spent liquor solution after the addition of alkali. The ammonia was absorbed in standard acid solution, the excess of which was later back-titrated. Slow boiling over a period of 2 hr. was used, and other conditions were standardized as closely as possible. This determination is readily reproducible under such conditions. It is intended to show the amount of nitrogen present as ammonium salt, and hence available for base exchange and as a pulping base. Whether or not it actually does so is not known, and this point should be further investigated.

Apparatus

The apparatus used to accomplish ion exchange consisted of six columns filled with resin, connected to each

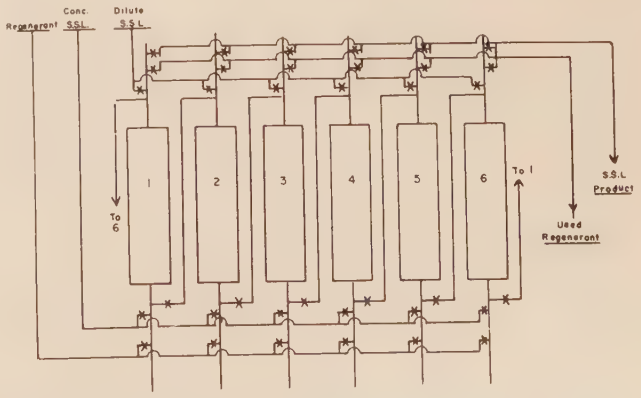

Fig. 2. Assembly of ion exchange ammonia recovery, system

Table IV. Amounts of Resin and Water Retained in Each Packed Column

	Column[a]						
	1	2	3	4	5	6	Av.
Wet resin, g.	514	485	497	511	497	493	500
Resin (dry basis), g.	279	263	270	277	270	268	271
Water below plate, ml.	14	10	11	14	12	18	13
Water above plate, ml.	207	190	..	215	195	188	200

[a] The volume of the resin bed in each column was calculated to be 590 ml.

other and to supplies of the various materials to be handled. Each column (see Fig. 1) was constructed of glass, about 2.56 in. i.d., and about 13 in. deep with a 7-mm. glass tube connected at the center of the bottom. A perforated porcelain plate was supported slightly above the bottom and held the resin. A column was filled with resin to a depth of about 7 in. Above the resin was a rubber stopper with a glass tube leading from the center. A perforated plate covered with glass cloth was fastened in the stopper and prevented the escape of resin through the tube. Surrounding each column was a water jacket about 11.5 in. high and 2.9 in. i.d. Cooling or heating water or steam was circulated through the jacket. The Dowex 50 resin was weighed into each column, and the volumes of water required to fill the columns up to the supporting plate, and then up to the top of the resin, were also measured and these data are presented in Table IV. The resin as charged to the columns on drying at 105° lost 45.7% of its weight.

The six columns were supported at the corners of a hexagon, as close together as conveniently possible and were connected as shown in Fig. 2. At the top of each column there was a connection to the following manifolds: liquor wash, liquor product, and acid product. At the bottom of each was a connection to manifolds connected to the liquor feed and the acid feed. At the top and bottom were connections for air vent and drain, respectively. The bottom of each column was connected to the top of the column next following. Connections were made with 7-mm. glass tube and short sections of rubber tube. Pinch clamps on the rubber tube served as valves.

The liquor feed line and the acid feed line ran through heat exchangers and were heated or cooled as desired. In the liquor product line was a conductivity cell to make possible the continuous observation of the conductivity of the effluent as a control means. A thermometer was also located in this line.

Procedure

Ammonia Absorption. The columns, after regeneration and drainage of acid product under suction, were ready. Then liquor feed was introduced into a column from the bottom, using the heating method in the column and preheater then being practiced. The temperatures of the liquor entering and leaving the column were periodically observed and recorded. The liquor product flowed through a conductivity cell and observations of the resistance in this cell indicated the course of the exchange. Usually the resistance first decreased (perhaps due to the increasing concentration at this time) then became nearly constant for most of the exchange cycle, and finally started to increase as the resin approached saturation with ammonia. When the desired change in resistance had occurred, the feeding of the liquor was stopped. The data taken during steps of ammonia absorption are shown in Tables V and VI along with compositions after various volumes had outflowed.

Table V. Example Data Taken During Ammonium Absorption on Column 6, Cycle 9

Time, min.	Liquor product, ml.	Cell resistance, ohms	Liquor temperature	
			Feed, °C.	Product, °C.
0	0	...	..	..
3	140	128	70	94
7	270	127	71	93
11	400	128	74	93
15	500	126	74	93
20	600	126	76	92
26	720	130	77	92
28	755	135	..	..

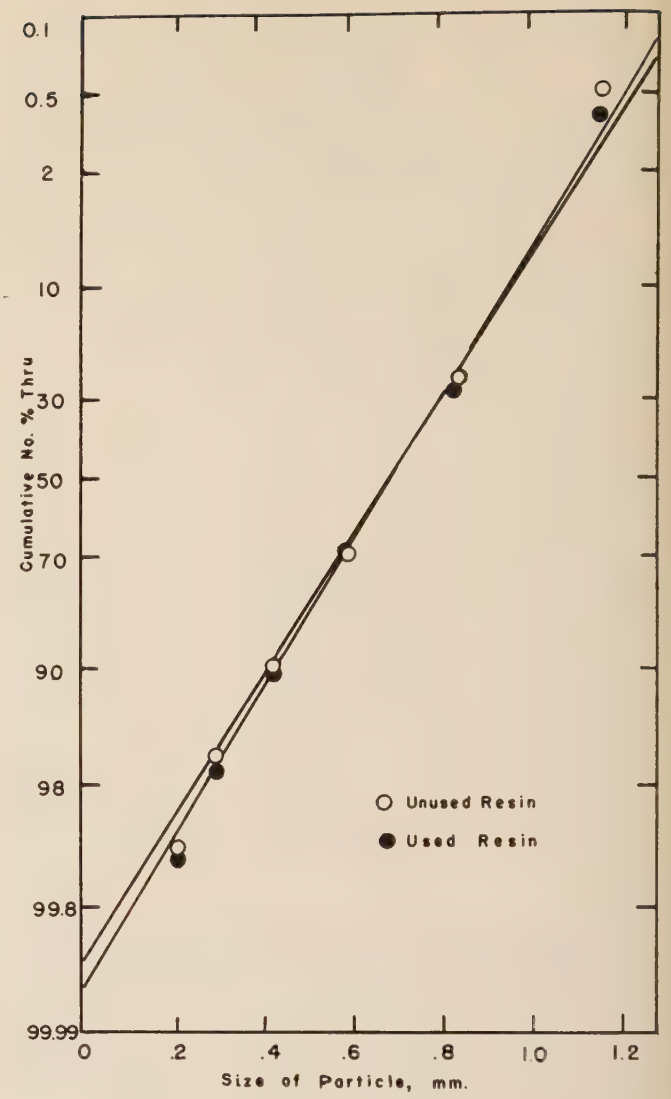

Fig. 3. Resin particle size distribution before and after 11 cycles use

In cycles 1 through 6, diluted liquor feed, containing about 140 grams of total solids per liter, was downflowed through the column as a wash. The first 100 ml. of outflow was collected and combined as liquor product. The later dilute liquor outflow was collected as liquor washings. The liquor remaining in the column was finally drained, under suction, and this liquid was collected as liquor drainings. In cycles 7 through 9, the washing was omitted, and the undiluted material drained from the column was put back into

Table VI. Analyses of Increments of Liquor Product[a] from Cycle 12

Increment	Liquor product collected, ml.	Cell resistance, ohms	Liquor product analyses: Total solids, g./l.	Alk. NH_3, g./l.	CaO, g./l.	Sulphated ash, g./l.
1	100	168	323	6.40	0.41	2.43
2	200	122	451	8.00	0.61	3.51
3	300	123	..	...	..	..
4	400	123	520	7.84	0.65	3.51
5	500	120	..	...	..	..
6	600	120	..	...	..	..
7	700	123	529	6.80	0.66	3.54
8	800	128	..	...	..	..
9	900	135	..	...	..	..
10	1000	147	523	10.08	0.62	3.54
11	1100	161	..	...	..	..
12	1200	174	525	11.48	0.61	3.89

[a] Temperature remained about 86°C. All increments were at pH 1.9 except 6, 7, and 8 which were at pH 1.8.

the reservoir for liquor feed. In final cycles, the flow of liquor feed was continued after the collection of liquor product was stopped, until the solution resistance became almost constant indicating the column to be nearly completely saturated with ammonia. The effluent collected during this period was immediately used as the initial feed in the next column.

The temperature was measured in the outlet tube about a foot from the outlet of the column. Consequently the liquor had some time to cool and the temperature observed was somewhat lower than that in the column, depending on the flow rate. In the first cycle, no heating was used. In the next few cycles hot water was the heating medium, and the observed temperature rose to a maximum of about 55°. Then, to obtain higher temperature, steam was used in the jackets and the observed temperature was raised to a maximum of about 85° although this maximum was reached only at the end of the exchange cycle. Finally, since it appeared that higher temperature might favor the exchange, the temperature was increased by first filling the column and then permitting only a slow flow rate while the steam heated the resin bed. The observed temperature maximum was usually not much different from that obtained in the preceding cycles but the temperature in the columns was actually higher and it was maintained at a high level throughout the whole cycle.

Ammonium Stripping. Ammonium ion was stripped from the ion exchange resin columns by a sulphurous acid solution containing about 30 grams SO_2 per liter and designated as acid feed. The volume of acid feed employed was regulated based upon the amount of sulphite spent liquor which had been treated in the column to be regenerated, i.e., the volume of acid feed employed corresponded to a use of about 1800 gal. of acid feed per ton of sulphite spent liquor solids which were assumed to correspond roughly to 1 ton of pulp. However, since the experimental measurements of volume were made on the somewhat diluted liquor product, the volume of acid feed actually used was somewhat higher than that planned on the above basis.

The stripping or regeneration was carried out on four columns in series with upflow of solution. The last column in the series was the one which had just been used for ammonium absorption for cycles 1 through 1 there was collected the acid product, and then the column was drained to obtain the acid drain solution. For other cycles only the acid product was collected. The first obtained acid product contained some sulphite spent liquor solids as exemplified by the compositions of the increments shown in Table VII.

The acid feed initially entering the columns cooled the resin. However for cycles 10 and 11, the acid feed and the columns were previously surface cooled by tap water at about 13°C., whereafter the temperature of the acid product was found to be 20, 17, and 16°C. for the first, second, and third liters, respectively.

Accumulations on the Resin Columns. After operation of the equipment through eleven cycles, and presumably the attainment of steady state, one of the columns (column 4) which had just been regenerated with sulphurous acid was exhaustively regenerated with 0.6 *N* sulphuric acid. Analysis of the resultant solution showed the presence of 7.25 grams NH_3, 0.69 gram CaO, and 3.95 grams of sulphated ash. The resin was washed, removed from the column, air dried, and then screen analyzed to obtain the results given in Table III and plotted in Fig. 3.

RESULTS AND DISCUSSION

The now-reported experiments have comprised treatment of a concentrated ammonium sulphite spent liquor of composition shown in Table II with ion exchange resin contained in six columns of the type shown in Fig. 1. The columns were assembled for cyclic operation using the connections indicated in Fig. 2. A sulphonated polystyrene resin crosslinked with about 8% divinyl benzene and called "Dowex 50" (kindly given by the Dow Chemical Co., Midland, Mich.) was screen analyzed with results shown in Table III and Fig. 3. The resin was charged to the columns in the amounts recorded in Table IV.

For operation, the desired quantity of concentrated ammonium sulphite spent liquor was upflowed through a resin column. Certain characteristics of the liquor product were observed as functions of the cumulative volume passed through the column as illustrated by the data of Tables V and VI. After completion of this ammonia absorption step, a sulphurous acid solution was then passed through four columns in series, and certain characteristics of the resultant acid product were observed as functions of the volume through with results given in Table VII.

The step of ammonia absorption was repeated for each of the six columns present to obtain one cycle of operations, and the effluent liquors were appropriately combined to yield liquor product and, for some cycles, the liquor washings and the liquor drainings. Likewise for one cycle, six ammonia regenerations were carried out, each time using four columns in series and proceeding around the bank of six columns in an ordered manner with the acid product stream passing finally

Table VII. Analyses of Increments of Acid Product from Cycle 4[a]

Increment	Acid product collected, ml.	Acid product analyses: Total solids,[b] g./l.	Alk. NH_3, g./l.
1	300	18.7	3.28
2	800	2.17	3.56
3	1000	1.24	2.60
4	1740	0.90	1.90

[a] This acid product was obtained from operation of columns 1-6-5-4 using 3840 ml. total volume of acid feed containing 33.3 grams SO_2 per liter.
[b] Estimated from measurements of optical density of solutions to ultraviolet radiation at 2800 A.

through the resin column which had just been used for the ammonia absorption. The acid products from each of the six stripping steps were combined. Eleven cycles were carried through, the operating conditions, analytical results, and material balances for these cycles are shown in Tables VII, IX, and X.

Calculation of Results

From the analyses given in Table VIII for total solids and Kjeldahl ammonia in the liquor product, the nitrogen-free solids in this product were calculated by difference, and these nitrogen-free solids were used as a basis for further calculations. The percentages of ammonia, calcium oxide, and sulphated ash in the liquor feed were calculated, based on nitrogen-free solids, from the data of Table II. From the amount of nitrogen-free solids in the liquor product, the amount of each constituent in the feed corresponding to these solids was calculated (Table IX). Similar calculations were made for the liquor wash and liquor drain, but for the sake of brevity the results are not included in Table IX. From the amounts of materials in the liquor feed to the column and in the liquor product, the amounts of materials retained by resin have been calculated (Table IX). In the later cycles, when no liquor wash was used, the data are complete in Table IX.

From the analytical data in Table VIII the amount of each constituent in the acid product was calculated (Table IX). In early cycles the liquid product was not analyzed for Kjeldahl ammonia, but from the results of analyses in later cycles it is shown that this figure is higher than the alkali ammonia by about 0.5 gram of ammonia per cycle in those cycles in which the resin was washed with dilute sulphite spent liquor.

After draining sulphite spent liquor from the columns, some sulphite waste liquor was retained in columns and appeared later in the regenerant. The amount of these solids as indicated by ultraviolet absorption was used as a basis for estimating (Table IX), the amounts of ammonia, calcium oxide, and sulphated ash corresponding to these solids and hence put into the column as sulphite spent liquor in excess of the liquor feed corresponding to the liquor product.

The rather indefinite meaning of "alkali ammonia" becomes apparent from an inspection of Table IX. Thus it appears that the amount of "alkali ammonia" retained by the resin from the sulphite spent liquor is greater than the amount retained of Kjeldahl ammonia, i.e., total nitrogen calculated as ammonia. This anomaly can be explained only by the assumption that "alkali ammonia" is in part converted to a form not liberated in the columns by alkali. To what extent this conversion takes place and whether or not it is reversible is not known. However, calculations involving differences of "alkali ammonia" content are necessarily subject to this error.

From the data in Table IX, the amounts of the several constituents on the columns at the end of each cycle can be estimated. Such estimates, however, show more hold-up on the columns than appears possible and more than is supported by the data on the regeneration of column 4 at the end of the eleventh cycle. Such differences must result from the accumulation of relatively small errors in the material balance data.

Table VIII. Results of Analyses of Ion Exchange Column Streams

Cycle no.	*Sample*[a]	*Volume, l.*	*pH*	*Total solids,*[b] *g./l.*	*CaO, g./l.*	*Sulphated ash, g./l.*	*Kjeldahl NH_3, g./l.*	*Alkali NH_3 g./l.*
1	Liquid product	6.02	1.52	463.0	0.049	0.38	3.11	1.12
	Liquid wash	3.60	3.59	299.2	0.290	2.22	12.2	10.97
	Liquid drain	1.48	3.17	162.9	0.064	0.85	6.53	5.75
	Acid product	26.0	..	2.95	0.006	0.26	..	2.58
	Acid drain[c]	2.0	..	2.80	0.00	0.01	..	0.18
2	Liquid product	5.61	1.60	483.2	0.123	1.47	8.21	5.94
	Liquid wash	2.10	3.60	358.2	0.431	3.08	15.0	13.12
	Liquid drain	1.40	3.18	172.3	0.070	0.96	6.95	6.15
	Acid product	24.3	..	3.23	0.040	0.66	..	2.53
3	Liquid product	5.24	1.49	482.4	0.277	2.01	10.4	7.94
	Liquid wash	2.10	3.41	317.3	0.362	2.75	13.4	11.32
	Liquid drain	1.31	3.28	174.3	0.088	1.22	7.00	6.35
	Acid product	22.65	..	4.86[d]	0.029	0.356	..	2.72
	Acid drain	1.00	..	.....	0.004	0.054	..	0.15
4	Liquid product	5.36	1.70	474.7	0.450	2.63	10.23	7.86
	Liquid wash	2.10	3.71	349.1	0.421	3.17	..	12.45
	Liquid drain	1.34	3.27	185.3	0.088	1.25	..	6.59
	Acid product	23.15	..	2.97	0.023	0.384	..	2.54
	Acid drain	1.08	..	.....	0.000	0.008	..	0.53
5	Liquid product	5.23	1.68	483.7	0.614	3.18	10.73	8.29
	Liquid wash	0.90	3.70	462.5	0.706	4.59	..	16.58
	Liquid drain	1.50	3.49	287.9	0.271	2.36	..	10.11
	Acid product	22.60	..	3.44	0.021	0.388	..	2.60
6	Liquid product	5.18	1.78	474.4	0.589	3.52	10.56	8.35
	Liquid wash	0.90	3.55	470.5	0.755	5.01	..	15.97
	Liquid drain	1.44	3.29	273.0	0.281	2.32	..	9.65
	Acid product	22.20	..	3.68	0.033	0.398	2.72	2.69
7	Liquid product	5.26	1.63	463.9	0.564	3.20	10.44	8.12
	Acid product	22.70	..	8.46	0.023	0.424	2.89	2.84
8	Liquid product	5.07	1.62	456.3	0.562	3.16	10.20	7.94
	Acid product	21.80	..	10.0	0.029	0.458	2.93	2.84
9	Liquid product	4.02	1.90	443.6	0.529	3.01	9.67	7.45
	Acid product	17.40	..	13.1	0.028	0.372	3.02	2.92
10	Liquid product	4.22	1.80	468.9	0.570	3.07	10.35	8.01
	Acid product	18.25	..	11.5	0.042	0.526	3.31	3.24
11	Liquid product	4.62	1.80	468.8	0.609	3.21	10.31	7.87
	Acid product	19.98	..	12.1	0.060	0.774	3.40	3.32

[a] Liquor products from cycles 1, 2, 3, 4, 5, and 6 were found to be of density of 1.175, 1.181, 1.179, 1.175, 1.178, and 1.176 g./ml., respectively.
[b] Total solids in acid product and acid drain samples were estimated by ultraviolet absorption and calculated to waste liquor solids.
[c] Acid drain samples from cycles 1 and 2 were combined.
[d] This figure is high because liquor leaked past a valve into the acid.

The ammonia recovery in each cycle has been estimated from the data of Table IX and is shown in Table X. Such calculations are complicated by several factors, e.g., the ammonia build-up on the resin in the early cycles, the failure of the material balance data to check completely, and the use in some cycles of wash liquor which left ammonia on the column but did not result in an effluent to be discarded from the process. The recovery data consequently have more significance after an increasing number of cycles, when temporary influences such as build-up in the columns can be averaged.

The calculation of ammonia recovery according to some formula, such as the pounds of ammonia returned to the pulping process per hundred pounds of ammonia fed to the columns, is difficult of application. Several alternative formulations have been used, and are given in Table X along with the results obtained therefrom.

Cycles 1 Through 5: Steady-State Operation Is Approximated

The first cycle was carried through at room temperature while the necessary manipulations were learned and tested. Here the resin was initially in the hydrogen form after regeneration with hydrochloric acid followed by exhaustive washing with water. Good ammonia removal from the liquor product was found (Table VIII) as was to be expected in view of the initial resin regeneration with strong acid.

The second cycle was started after making some minor changes shown during the first cycle to be necessary. Hot water was circulated through the column jacket and the sulphite spent liquor preheater during the exchange cycle. At the resultant temperature of about 55°C., the flow rate was much more rapid. Previous economic calculations were based on an estimated time of about 30 min. for the exchange cycle, and this time was approximated in the second and following cycles. The pressure required to produce this flow rate was provided by 6 ft. of liquid head. However, the major resistance to flow was in the glass cloth support for the resin at the top of the column.

The removal of ammonia, calcium, and sulphated ash was nearly complete in the first cycle. In the second cycle it was less, and in the third cycle it was still less so. However, the ammonia removal per cycle changed very little after the third cycle, and thus during the third cycle the steady state from this standpoint has been reached. The calcium removal diminished with each cycle until the fifth, at which point there was no further decrease. The removal of sulphated ash decreased with each cycle up to the sixth. The quantity of liquor treated in each cycle decreased during the first three cycles, but then assumed nearly a constant value as long as there was no change in the operating conditions.

Cycles 5 Through 8: Absorption at 85°C.; Liquor Feed Decreased

After five cycles, operations were continued using higher temperatures. Steam heat in the preheater usually brought the feed to about 95°C., and the column jackets compensated for heat losses and raised the temperature further. The flow rate increased somewhat at the higher temperature due to increased fluidity of the liquor. Difficulties were experienced in the resistance measurements due to gas evolution from the effluent, causing foam or bubbles in the cell. This gas evolution was no doubt caused by the release of carbon dioxide and sulphur dioxide from the liquor on acidifying the carbonates and sulphites by base exchange. A gas trap reduced this trouble, but did not eliminate it entirely.

A significant increase in the ammonia recovery was noted when the temperature during the exchange step

Table IX. Disposition of Materials in Ion Exchange Resin System Operations

	Cycle no. 1	2	3	4	5	6	7	8	9	10	11
Material in Liquor Product, Grams											
Solids	2790	2710	2520	2530	2520	2450	2435	2315	1780	1970	2160
Kjeldahl NH_3	18.7	46.2	54.4	54.4	56.2	54.5	55.0	51.7	38.8	43.6	47.5
Alkali NH_3	6.73	33.4	41.6	42.1	43.3	43 2	42.8	40.3	29.9	33.8	36.3
CaO	0.30	0.69	1.45	2.40	3.21	3.04	2.97	2.85	2.12	2.40	2.81
Sulphated ash	2.28	8.25	10.5	14.1	16.6	18.2	16.8	16.0	12.1	12.9	14.8
Material in Liquor Feed, Corresponding to Solids in Liquor Product, Grams											
Kjeldahl NH_3	122.5	117.9	108.8	109.1	108.8	105.9	105.1	100.2	77.1	85.2	93.6
Alkali NH_3	112.8	108.6	100.3	100.6	100.3	97.4	96.9	92.1	71.0	78.4	86.1
CaO	3.55	3.42	3.16	3.16	3.16	3.06	3.05	2.90	2.23	2.47	2.71
Sulphated ash	35.8	34.5	31.9	31.9	31.9	30.8	30.7	29.3	22.5	24.9	27.2
Material Retained by Resin from Liquor Feed, Grams											
Kjeldahl NH_3	105.9	72.5	54.9	54.4	52.8	51.4	50.1	48.5	38.3	41.6	46.1
Alkali NH_3	109.5	77.2	61.3	64.4	59.9	57.8	54.1	51.8	41.1	44.6	49.8
CaO	3.73	2.95	1.92	0.97	0.06	0.08	0.08	0.05	0.11	0.07	0.10
Sulphated ash	40.5	30.7	25.0	21.7	18.0	14.8	13.9	13.3	10.4	12.0	12.4
Material Retained in Columns as Liquor After Draining, Grams											
SWL solids	79	81	112	71	80	84	196	223	232	214	246
Kjeldahl NH_3	3.3	3.4	4.8	3.0	3.4	3.5	8.3	9.5	9.8	9.1	10.4
Alkali NH_3	3.1	3.2	4.4	2.7	3.1	3.3	7.7	8.7	9.0	8.4	9.6
CaO	0.10	0.10	0.14	0.09	0.10	0.10	0.24	0.27	0.28	0.26	0.30
Sulphated ash	1.0	1.0	1.4	0.9	1.0	1.0	2.4	2.8	2.9	2.6	3.0
Material Removed in Acid Product, Grams											
Kjeldahl NH_3	.....	.....	.....	.....	.....	60.4	65.6	64.2	52.6	60.4	68.0
Alkali NH_3	66.0	61.8	61.9	58.9	58.9	59.9	64.5	62.1	50.9	59.1	66.4
CaO	0.16	0.98	0.66	0.53	0.48	0.73	0.52	0.63	0.49	0.75	1.20
Sulphated ash	6.8	16.0	8.1	8.9	8.8	8.8	9.6	10.0	6.5	9.6	15.5

was increased. At the same time that the temperature of the exchange step was increased, another significant change in the operation was made. It will be noted in Table X that in the first five cycles, the liquor product was collected until the resistance in the control cell was from 60 to 80% higher than at the average value near the middle of the exchange step. During the next three cycles this increase of resistance was kept to about 30 to 40%. A decrease of sulphite spent liquor solids treated per cycle of about 5% resulted. To what extent the increased percentage recovery of ammonia was due to the increased temperature, and to what extent to the shorter cycle, is not known. Probably the shorter cycle is more important.

Cycle 9: Absorption at 90°C.; Liquor Feed Further Decreased

In the ninth cycle the temperature was further increased, and the collection of product was stopped more quickly after the beginning of the increase in resistance in the cell. The increase in resistance, in this and following cycles, was held to 7 or 8%. The temperature increase was obtained by decreasing the flow rate at the beginning of the cycle so that the resin bed could be heated in the early part of the cycle. As a result, the average temperature increased considerably although the maximum temperature was only slightly higher than before. The ammonia recovery increased in this cycle to about 59%.

Cycles 10 and 11: Absorption at 90°C.; Resin Saturated with Ammonium; Acid Cooled

In the last two cycles, the temperature of exchange was kept high, but two changes were made which it was hoped would further improve the operations. One was to continue the flow of liquor feed through the column after the collection of product was stopped, to take full advantage of the capacity of the resin by saturating it completely. The effluent collected during this period was used as feed for the next column. The other change was to cool the acid feed with tap water at about 13°C. and to run cooling water through the jacket in the columns. The acid product, after such cooling, was at a temperature of about 16 or 17°C. Cooling was carried out to increase the strength of sulphurous acid, which has been reported by Johnstone and Lepple (*12*) to be a substantially stronger acid at lower temperatures.

The ammonia recovery in the last two cycles increased to about 63 or 64%, and simultaneously the amount of material treated per cycle was increased considerably.

Resin Stability and Loss

The distribution of particle size of the resin was found to be substantially the same within experimental error before and after the eleven cycles of operation described above (Table III and Fig. 3). These screen analyses were dependent on the moisture content of the resin and could not be duplicated unless precautions were taken to insure uniform swelling.

The resin particles were spherical, hence broken particles were easily detected. It was observed that the use of the resin did not lead to a noticeable increase in the number of broken particles. The resin did become darker on use, however, probably because of adsorption of colored sulphite spent liquor constituents.

Our figures show that about 10% of the resin in column 4 was lost during use. During the operation of the apparatus, small amounts of resin were noticed escaping past the perforated plates in the bottoms of the columns. Since these perforations were of 1 mm. diameter it is not surprising that resin particles with the size distribution shown in Table III should be lost through them in considerable amount. It is believed that such losses account for all of the 10% noted above and could largely be avoided in large-scale operation.

Possible Improvements in Process Operation

If the type of apparatus used for present experiments should be operated on larger scale under the conditions of cycles 10 or 11, it is believed that better results would be obtained than now observed because: (1) better control and stability of operating variables could be realized when dealing with larger volumes of liquor and sulphurous acid; (2) mechanical losses such as leakage could be largely avoided; (3) reversion of "alkali ammonia" to nonionic nitrogen compounds could be

Table X. Ammonia Recovery for Cycles

Cycle no.	Operating conditions[a]				Ammonia recovery[b]			
	Max. temp., °C.	Time abs., min.	Resis. Increase at liquid product cut off, %	Liquid product solids per acid product vol., g./l.	c, %	d, %	e, %	f, %
1	25	100	79	103	85	52	78	53
2	55	34	84	107	61	50	58	51
3	55	30	60	106	50	53	53	54
4	55	33	63	104	50	52	52	53
5	55	21	61	111	48	51	51	52
6	85	18	40	110	49	54	53	55
7	85	16	29	107	48	55	54	57
8	85	12	30	106	48	55	56	57
9	90	25	7	102	50	55	58	59
10	90	..	8	108	48	60	58	63
11	90	..	7	108	49	62	59	64

[a] Operations were conducted in cycle 1 without heating, in cycles 2 through 5 with water heating, and in cycles 6 through 11 with steam heating. Acid feed was cooled only in cycles 10 and 11.

[b] Ammonia recovery has been calculated from data in Table IX and exemplified for cycle 11 by definitions given as *c*, *d*, *e*, and *f*.

$$c\ \frac{\text{(Kj. N in liq. feed} - \text{Kj. N in liq. prod.)(100)}}{\text{(Kj. N in liq. feed)}} = \frac{(93.6 - 47.5)(100)}{93.6} = 49\%.$$

$$d\ \frac{\text{(Kj. N remvd. in acid} - \text{Kj. N ret. in col.) (100)}}{\text{(Kj. N in liq. feed}} = \frac{(68.0 - 10.4)(100)}{93.6} = 62\%.$$

$$e\ \frac{\text{(Kj. N remvd. in acid prod.)(100)}}{\text{(Kj. N remvd. in acid} + \text{Kj. N in liq. prod.}} = \frac{(68.0)(100)}{(68.0 + 47.5)} = 59\%.$$

$$f\ \frac{\text{(Alkali N remvd. in acid)(100)}}{\text{(Kj. N in liq. feed} + \text{Kj. N ret. in col. as liq.)}} = \frac{(66.4)(100)}{(93.6 + 10.4)} = 64\%.$$

minimized by immediate processing of liquor from evaporators (note in Table II that on storage of the feed sulphite waste liquor from Oct. 2 to Nov. 24, 1950, the alkali ammonia decreased from 92 to 87% of the total; the observed decrease from pH 4.17 to pH 3.55 probably in part reflects this ammonia transformation); (4) column channeling could be minimized by better avoidance of an entrapment.

If the type of apparatus used for present experiments should be operated on large scale but with certain departures from conditions used in cycles 10 or 11, somewhat better ammonia recovery should be realized. To obtain better removal of ammonium from the sulphite spent liquor fed to the process, the major and important need is for more extensive resin regeneration which might be accomplished either by use of a resin with more favorable dissociation constant, or of increased volumes of regenerant or concentration of sulphurous acid therein. The feasibility of using one or another of these approaches must be decided by economic balance calculations.

An additional step could be taken to effect nearly complete ammonia recovery. The resin, perhaps preferably after regeneration with sulphurous acid, could be further regenerated with sulphuric acid. The effluent from this regeneration, containing some excess sulphuric acid, could then be neutralized with ammonia and evaporated to produce ammonium sulphate for fertilizer. Economic factors would determine the desirability of such operation.

Preliminary Estimate of Requirements for 100 Ton per Day Pulp Mill

Based on the small scale experiments here reported, the following very rough estimates have been made relatively to a 100 ton per day sulphite pulp mill: (1) Time required for a cycle using elevated temperature in ammonia absorption can correspond to at least 16 cycles per day. (2) Capacity of resin per cycle in the cycle 11 type system indicates the weight of resin required is about 12,000 lb. dry resin per 100 tons pulp daily production. (3) This is 410 cu. ft. of resin and with a six column system, each column would contain 70 cu. ft. of resin and could be 3.5 ft. in diameter and 7.3 ft. deep in resin. Height of columns should be perhaps 8 to 10 ft. to permit swelling. (4) Backwashing arrangements should be provided. (5) While present results have been obtained using 3% sulphurous acid regenerant equivalent to 1800 gal. per ton of pulp produced, regenerant volume is of great importance and should be made as great as possible.

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Screening of Sulphate Pulp

Modern Swedish Practices and Developments

GUSTAF RANHAGEN

The screening problem has become more and more important in Sweden because of the raw material situation and market demands on quality. Different types of screen equipment are segregated into groups according to their construction and method of operation and are compared as to their dirt removing properties. Different dirt particles are considered with reference to the different types of screen equipment. In order to obtain the best result as to cleanliness, capacity, as well as water and power consumption the best operating consistency should be held constant at every point along the screen surface. This is generally valid for all screens of the dewatering type. It is stated that no single screen on the market gives a good result in all respects but the different groups mentioned have their own very marked characteristics. A combination or double screening is to be preferred when the demand on cleanliness is high. The modern, high frequency vibratory screens, centrifugal screens, and vortex cleaners have good possibilities in combination. Using double screening with high frequency vibratory screens with slotted plates in combination with centrifugal screens, the best results have been obtained when the former are placed first in the series. The system used is of greater importance than the individual screen. The system should be designed to permit each integral unit to work at optimum conditions. The design of the secondary and tertiary part of the screen room is of vital importance for cleanliness and economy. The accepted stock from the secondary and tertiary screens should be recirculated to the primary screens. The use of screening is theoretically considered from a statistical point of view in that the effect of every single screen in a combination of two, needs only to be the square root of that of the single screen to give the same result.

During recent years the screening problem has become more and more important in Sweden because of several reasons. The Swedish cellulose industry difficulties exist in part due to the raw material situation.

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Owing to a reduced supply of wood for pulp production and to some extent to labor, certain kinds of wood such as waste wood, hardwoods, etc., which previously have not been used for pulpmaking but only for fuel and other purposes, today must be utilized for cellulose manufacture. These raw materials have caused difficulties as to the cleanliness of the product even if from a cellulose point of view it is otherwise of excellent quality. The labor shortage has compelled the industry to clean and bark the wood in the mill instead of barking in the forests. It is calculated that about 60% of all labor costs in the forests are due to barking.

At the same time that these difficulties arose, the market demanded higher and higher qualities especially in regard to pulp cleanliness, and certain kinds of paper, for example insulating grades, which must have exceptionally high cleanliness to be useful, have gained in importance. For those in Sweden, who are exporters to a great extent, this is, of course, a problem of especially great consequence.

Of course, cleanliness of the pulp is not obtained in the screening room only, but is a function of the pulping process itself to a great extent. It is believed that it can be said, however, that with screening done in an efficient way good results can be obtained with a relatively small investment compared with what can be obtained with a corresponding investment in other parts of the process, such as wood cleaning, cooking, and bleaching for example.

SCREENING EQUIPMENT AND NOMENCLATURE

This discussion will begin with the most common screening equipment used in the Swedish sulphate mills. To make it easier to explain the different screening systems, a code has been prepared to aid in the interpretation of the different flow sheets. Any kind of screen or a screen room is indicated as in Fig. 1. Stock entering at the base is called *charge*, *accepted stock* is at the top, and *reject* is at the side.

The different equipment which is available is divided into groups according to construction and way of working.

A. Low frequency vibratory screens of the flat screen type are still very much used and work at a stock consistency of about 0.3%. The rotary low frequency screens are not generally used for brown stock screening. As mentioned later, flat screens are excellent as secondary and tertiary screens because they are very easy to regulate.

B. The high frequency vibratory screens of the flat or rotary type have been developed in Sweden in recent years and are characterized by their ability to screen stock at high consistency, i.e., 1.5 to 2.5%. They require a relatively small amount of water, have a high capacity per unit screening surface, low power consumption, and low space requirements. They are used mostly for the final screening, but evidently they are doing a good job even in the first screening.

In common for all screens in groups A and B is the inability to eliminate effectively dirt of the sliver or shive type of the same or less thickness than the cut. The capacity decreases very rapidly with finer cuts, for example, by about half from cuts of 0.014 to 0.010 in., and proportionally still faster if it is reduced more, in which case the capillary effect becomes important.

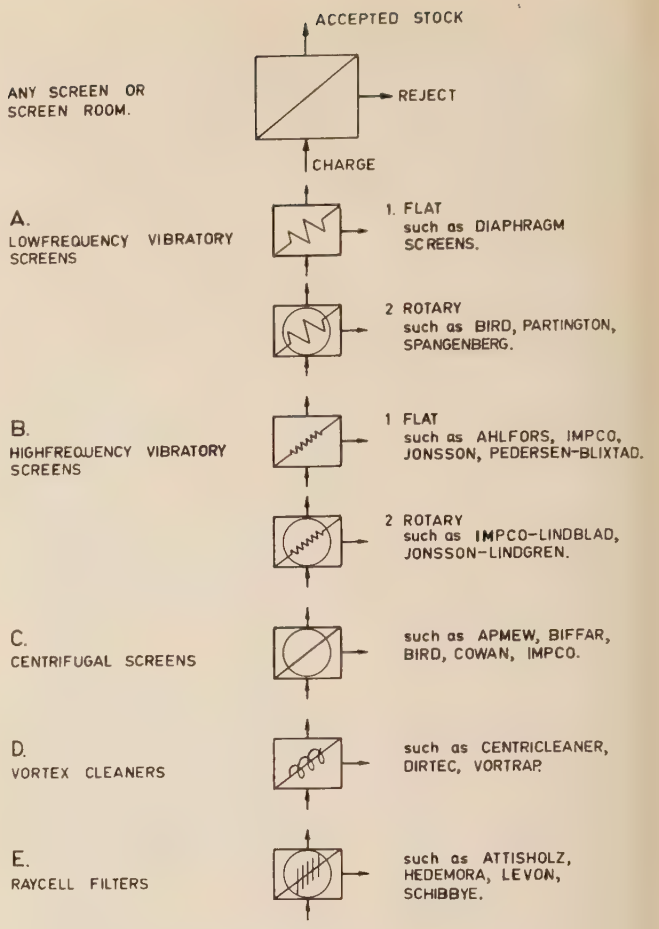


Fig. 1. Screen equipment nomenclature and code.

(a) Screens in general or a screen room. (b) Different type of available screens.

Due to the facts mentioned above, when using only fine cut plates the screen room will have very large dimensions. Unfortunately, the cleanliness of pulp is not increased proportionally to the reduction of the screen cut size. The time during which the stock is in contact with the screen plates is more important, i.e., large overflow and short time are more important for cleanliness of the accepted stock than finer cuts.

C. The centrifugal screens, the most important group for sulphate pulp, are characterized by their ability to remove the long particles (sliver and shives), but they accept the dirt of a spherical shape of the same size as the perforation. However, quite a lot of these small dirt particles can be removed by these screens if the right consistency is held constant at every point on the screen surface, which consistency is a function of the screening property of the stock. The load and overflow must be regulated to give the screening surface a fiber layer or filter through which the cellulose fibers are screened. Such a layer is of greater importance for the screening result than the choice of perforation, i.e., the diameter of the plate holes.

Centrifugal screens with axial flow accept the fines and short fibers such as raycells, in the first part of the screen drum. The composition of the charge is therefore changing gradually along the screen surface and the long fibers and shives remain, causing the dewatering property to change. The fibers following the rejects from the screen are therefore the longest and for many purposes the most desirable.

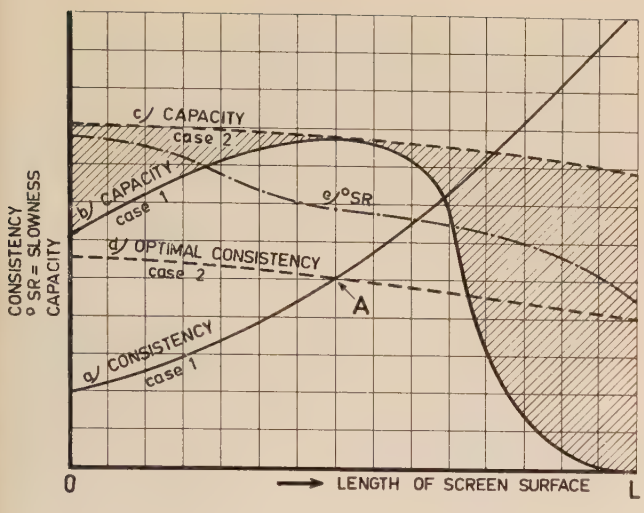


Fig. 2. Graphs illustrating the screening property along a screen surface

Case 1: Dilution before stock entering the screen. Consistency curve (a) and corresponding capacity curve (b). Case 2: Dilution along a screen surface in relation to the optimal consistency, curve (d) and corresponding capacity, curve (c). Curve (e) illustrating the change of the dewatering effect. °S.R.

The filtering layer in the centrifugal screen is of extremely great importance. Under conditions the accepted stock can be as clean at the overflow side as at the inlet side with the same perforation. A negative property of the centrifugal screen is that dirt particles, due to manner of the centrifugal screen's operation can be disintegrated easily. Characteristic of the screens in this group is the defibrating effect.

D. The vortex cleaners, in their modern design, are gradually taking over the role of the sandtrap for separating particles with higher specific gravity as well as a large portion of the shives and bark. The conventional sandtrap has a very low efficiency at consistencies above 0.5%. The vortex cleaners, such as the Vortrap, Dirtec, and Centri•cleaner also remove quite a lot of dirt such as slivers and bark. This property improves if the apparatus is allowed to work with a free vortex that is obtained if the apparatus is given free discharge. It is of advantage to place the vortex cleaner as early as possible in the process to make the work easier for the subsequent screens. This increases the capacity of the screen, improves the screening result, and reduces wear and tear. The new American development in this field, i.e., the Centri•cleaner, has had great interest in Sweden. The vortex cleaners, though they cannot replace the conventional screens, are a good and often desirable complement to the system.

E. The ray cell filters are used for removing the free ray cells and also fiber fragments and finer particles from the stock. The risk of forming sticky lumps in the subsequent process decreases if the ray cells are removed, the brightness of the pulp increases, and its chlorine number decreases (of special concern with sulphite pulp). The different equipment, shown in Fig. 1, work on the principle that if a fiber suspension is sprayed at relatively high speed against a fine mesh wire, most of the free ray cells are forced through the wire and removed.

Ray cell filters could be applied in the preparation of wastepaper stock instead of deinking deckers.

THE OPTIMUM CONSISTENCY

There is really no complete barrier for dirt in any kind of a screen. In most cases holes and slots are sufficiently large to allow most dirt particles to pass.

Figure 2 shows the operation of most kinds of screens and shows the importance of keeping an optimum consistency along the screen surface. As known, a stock can be screened only up to a certain consistency depending upon the screen device used. If, with the help of this graph, case 1, where the stock is sufficiently diluted before the screen to make use of most of the screen surface is compared with case 2, where the stock has a consistency corresponding to the optimum consistency from the start and where the water thereafter is added in direct proportion to the remaining stock and its properties in every point of the screen, the following will be found.

In case 1 the stock is dewatered rapidly, and the screening property goes to zero and with that the capacity. The fibers are choking up the cuts or perforations. To be able to make use of the screen the inlet consistency must be kept very low, i.e., quite a lot lower than the optimum consistency, and the capacity of the screen cannot be fully utilized (see curves a and b).

In case 2 the charge is at the optimum consistency from the start and held throughout the screening operation by adding water (see curve d, Fig. 2). This optimum consistency is influenced by the change of the dewatering property of the stock. As already mentioned, the dewatering property is influenced by the early removal of fines, such as ray cells, so that the stock composition has a higher percentage of coarse fibers and dirt (compare the curve e, Fig. 2). At higher freenesses more water is needed to screen the same amount of fibers. The loss in capacity, between case 1 and case 2, corresponds to the shadowed portion in the graph. The saving in water in case 2 as compared to case 1 is more obvious than differences in capacity.

In case 1 the cleanliness, especially for centrifugal screens, is best in point A which shows that the optimum consistency gives the best screening conditions. After point A, the cleanliness decreases partly because the concentration of the dirt in the pulp on the screen decreases with the flow along the screening surface. An increase of the charge will cause the part OL of the curve to move to the right and finally results in an overflow of fibers in the rejects. Foster (*1*) has found that the accepted stock, under certain conditions, can be cleaner toward the L rather than the O side of the screen. Our tests indicate the same when the charge is large, i.e., large overflow and too low an inlet consistency. If the optimum consistency is held constant (compare case 2) the cleanliness is higher toward the O side, i.e., toward that side where the initial cleanliness is highest.

The optimum consistency is a function of the composition of stock, freeness, etc., and is dependent on the kind of screening device. For low frequency vibratory screens the optimum consistency is about 0.5 to 0.6%, for a high frequency screen of the flat type 1.5%, and for a rotary high frequency screen 2.5%. For centrifugal screens the consistency is 1.2 to 1.3%. These consistencies refer to standard Swedish sulphate pulp.

DIRT SEPARATING PROPERTIES OF SCREENING EQUIPMENT

Figure 3 shows some typical dirt particles in con-

nection with the screening equipment mentioned above. Figure 3b is a typical picture of dirt particles which have been accepted by hole perforated plates in centrifugal screens. They are mostly round or spherical. The centrifugal screen, as previously mentioned, very effectively removes the long particles as shives.

Figure 3a shows the types of dirt which have passed through slotted plates in the types of screens that have been called low or high frequency screens. The dirt is mostly of the shive type and few of the type that passed the centrifugal screen will be found.

The impurities in sulphate pulp mostly consist of bast and shives, originating from knots, surface wood, rotten wood, etc. as well as bark. Bark particles are more common in sulphate than in sulphite pulp, and do not degrade the unbleached pulp as much, partly owing to the dark color of the sheet and partly to the relatively small contents of bark compared to the shive contents. When the sulphate pulp is refined the shives are defibered and when the pulp is intensively refined, only the specks from the bark remain.

As is known, in most cases papermakers do not do too much refining which makes the shives the most objectionable dirt in an unbleached paper. For sulphate pulp intended for bleaching shives and bark are definitely undesirable because it is not possible to bleach all of them and therefore they affect considerably the cleanliness of the bleached pulp and paper. Of course, under certain conditions and by adding more chemicals, quite a lot of dirt can be eliminated in bleaching, but this affects the yield and the quality negatively. The pulp that has been freed from its dirt by refining only, needs more heat and chemicals to obtain the same brightness as a pulp which has been carefully screened. Sulphate pulp should therefore (this is especially the case with pulps which are intended for bleaching) be very carefully screened.

It has been said that the shives are the most common and objectionable dirt in sulphate pulp. Because of this the centrifugal screen is the type most suitable for this kind of pulp, and this screen is the one most commonly used in Sweden for screening sulphate pulp.

When making pulp from pine or spruce the pitch which originates from the ray-cell fibers is dissolved in

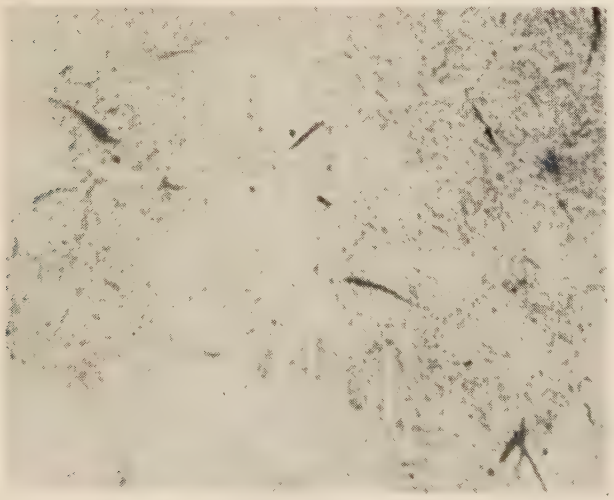
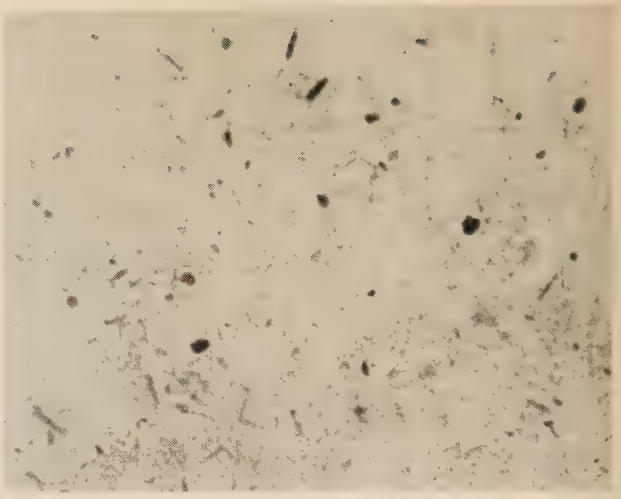


Fig. 3a. Types of dirt from high and low-frequency screens with slotted plates



Figs. 3b. Types of dirt from centrifugal screens with hole perforated plates

the alkaline cooking liquor. Operating with hardwood such as aspen and birch, pitch troubles similar to those occuring in the sulphite process have been encountered. The hardwood pitch is not soluble in alkaline liquors to the same extent and, especially in the bleached grade pulp, can be baked together to form sticky lumps which cause troubles in the papermaking. This problem has not been fully solved, but laboratory tests completed so far indicate that the extractive pitch contents can be lowered by about 60% using ray-cell filters.

The cork bark, if not removed by barking, seems to affect the pitch extract contents. Another undesirable particle which is almost impossible to remove by screening is the fibers in which lumen is filled up with a dark substance which cannot be bleached. Of course, such undesirables and common interest for only high-grade bleached qualities.

In addition to the characteristic dirt particles already mentioned there are others which do not originate from the wood but are introduced during the process, for instance with the water, air, etc. Most of these particles cannot be eliminated easily by the screening, and an attempt must be made to eliminate them at the source, for example by reducing the water consumption in the screening process itself.

SCREENING SYSTEMS

From the above it is therefore obvious that the efficiency of dirt removed for different kinds of screening equipment must be very different. None of the screens mentioned gives good results under all conditions but every type has its own very marked effect on certain kinds of impurities. Therefore, a combination of different types of screens which complement each other, a repeated screening or double screening should give a better result than a single screening. Double screening implies that the accepted stock from one screen is rescreened on another screen.

The double screening gives a more even screening result and especially reduces or eliminates the risk of dirt acceptance by screen plate damages, etc. In the recent years with the modern high frequency screens and vortex cleaners on the market, there are good possibili-

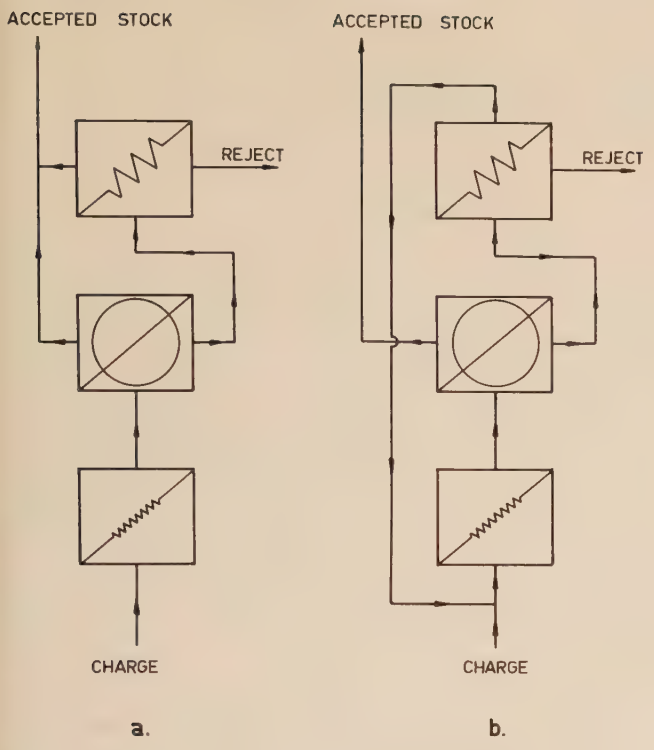


Fig. 4. Conventional coupling (a) and improved coupling (b)

ties to design compact double screen rooms. The combination chosen is of a greater importance as is the choice of the individual screen.

For sulphite pulp, where cleanliness demands are generally higher than for sulphate pulp, a double screening system has been used for a long time. It has been found that technically there is no principal difference between screening of sulphite and sulphate pulps. We have therefore started to apply the same principle in designing screen rooms for both kinds of pulp. Most of our experience from double screening has been obtained from sulphite. Of course, the economies involved for a certain screening department must be taken into consideration.

However, most sulphate mills use centrifugal screens in one stage only after the knotters. The pulp is first thickened and then treated in kollergangs to refine the shives and dirt particles, which despite the screening are present in the accepted stock. Several mills, especially converters, have started to use refiners according to American practices, but in Sweden and the Scandinavian countries the kollergang is preferred because it is believed that these machines besides having a "curlating" effect and disintegrating the slivers also have a beneficial effect on the removal of the remaining liquor within the fibers.

In principle the impurities should, however, be removed before the refining stage and not be blended in the stock through refining. In most cases, for instance, the shives have different characteristics than the fully separated fiber material, a different chlorine number, and other papermaking properties.

SULPHATE SCREEN ROOM DESIGN

It is obvious that the main difficulty in the planning of screen rooms is to design the secondary and tertiary stages to handle stock which has a very low initial cleanliness. These stages have also to be designed with the understanding that the primary stage shall be run at maximum efficiency. In a screen room with well-balanced flow the cleanliness of the accepted stock is a function of the fiber losses.

Figure 4a shows a flow sheet for a conventional screen room for a small mill. The low frequency screen is used to permit the centrifugal screen to work effectively with overflow. As mentioned above the slotted plates will accept dirt of sliver and shive type which the centrifugal screen effectively rejects. This stock is considerably dirtier than that from the centrifugal screen even if equipped with fine slots. Therefore, it is of advantage for improved quality of the finally accepted stock to couple as in Fig. 4b, which shows how the accepted stock from the low frequency screen is returned for re-screening. In this manner there is an additional opportunity to reject the dirt particles. However, the result depends on a uniform feed and uniform flow on the secondary stage. This is obtained by means of a mixing chest with an agitator, large enough to even out fluctuations; automatic level control of overflow; consistency control; and variable vibration of the screen. The diaphragm flat screen is excellent for this purpose as it is easy to control. Another important advantage is the water saving since the diluted accepted stock from the secondary screen is used as dilution of the charge to the knotter.

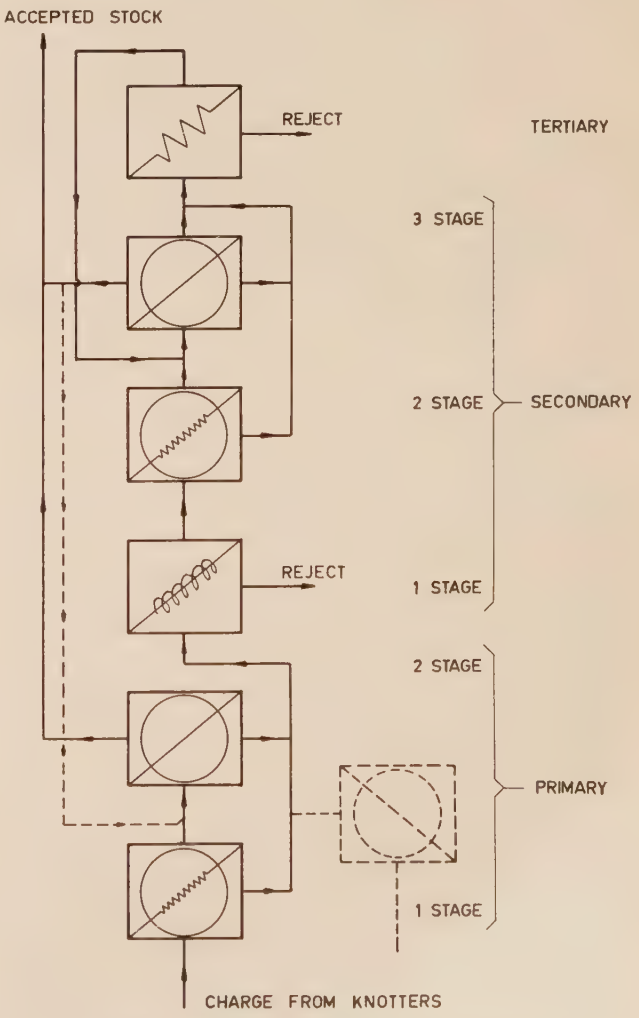


Fig. 5. Flow sheet for double screening

For a larger mill it is more economical to use the high frequency rotary screen with a subsequent flat screen, as shown in the secondary part of the flow sheet in Fig. 5.

Figure 5 shows a double screening coupling for qualified screening where it is proposed to use centrifugal screens and high frequency rotary screens in combination with vortex cleaners.

The deknotted stock is screened on rotary high frequency vibratory screens in the first stage, the accepted stock from which is rescreened on centrifugal screens. The overflow is screened on a secondary stage made up of vortex cleaners and high frequency vibratory and centrifugal screens. For the tertiary stage which has to handle the overflow from the secondary stage I a low frequency flat screen has been proposed. In such a design it is possible to give all the units in the screen room the possibility of yielding their maximum results.

If the accepted stock from the secondary stage is not as clean as the stock from the primary stage, it should be returned to the primary stage.

The coupling to determine which screen is to be placed first in line has been closely studied. All tests made so far indicate that the best cleanliness is obtained when the high frequency vibratory screen with slotted plates is placed first, followed by the centrifugal screen. This is believed to be due to the defibrating effect of the centrifugal screen which causes dirt particles to be broken up into finer ones which can be accepted easier. The first screen with slotted plates removes the spherical or round particles, while the shives are best removed by the centrifugal screen. In fact, the screening property for the subsequent centrifugal screen is more favorable after this first screening and the best operating consistency is higher, which means a saving of water.

Another important consideration is that the vibratory high frequency screen can run at higher optimal consistency while the centrifugal screen must be operated at lower consistency. If the centrifugal screen is placed before the vibratory screen, a filter for dewatering would be required before the accepted stock could be rescreened.

Both screens have to work with overflow to a secondary screen from which accepted stock is returned according to above-mentioned principles.

THEORETICAL APPROACH TO THE SCREENING PROBLEM

An important contribution to the theory of screening and screening system design has been made by Steenberg (*2*) and was discussed at the 1953 Spring Convention of the Swedish Paper and Cellulose Engineers Association. His statements which are chiefly concerned with selective screening on a statistical point of view, are of special interest and are confirmed by practical results.

He says in the first of his screening rules: "It is a statistical rule that the chance of the occurrence of two independent constellations or events is the product of the probability of each event." This rule is the basic thought behind the double screening principle of the type which has been advocated in this paper. Assume two screen stages connected so that the accepted stock from the first stage is used as the charge for the second stage and that the probability of dirt acceptance in the

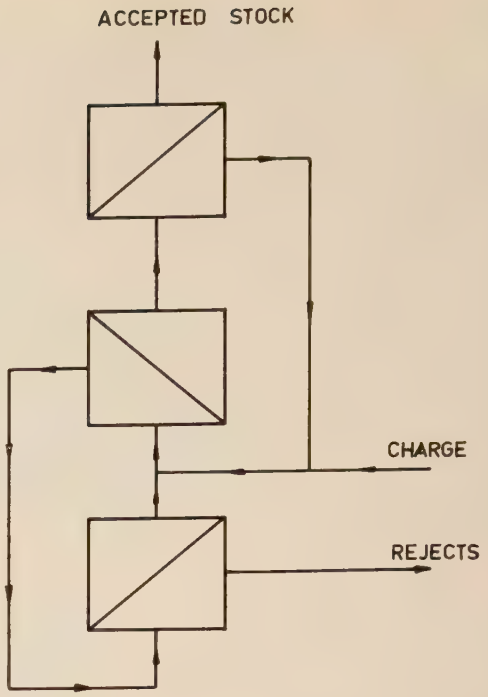


Fig. 6. Three-screen system according to Steenberg

first stage A_1 and in the second A_2. Then the probability for dirt in the accepted stock from the secondary screen is $A_1 \times A_2$ and because both A_1 and A_2 are figures considerably below 1.0 it will be very difficult to design a single-screen stage where the same result can be obtained. This is what he calls the coupling rule.

A second or mixing rule is that streams or flows of stock in a system should be connected so that the cleanliness is not changed.

A third rule is the minimization of water requirements.

The demand on a screen must be considered to be extreme if it is expected that it should separate material of quite different types in one single operation. When separating dirt particles from pulp it is therefore more logical to use several screens, two or more screens in series, than to go too far in trying to improve the single-screen design. If two identical screens which are placed in series are compared with only one screen of the same type, the effect of every single screen in the combination by reason of the above principle, needs to be the square root of that of the single screen to give the same result. From this follows that a combination is to be preferred even from the statistical point of view.

Figure 6 shows the three screen systems Steenberg states to be the best from a statistical point of view if the factors, fiber loss and water consumption as a function of cleanliness, are taken into consideration.

The results obtained in practical application of double screening of sulphite pulp check very well with these theories and the same good result can undoubtedly be obtained also in double screening of sulphate pulp.

LITERATURE CITED

1. Foster, J., *Pulp Paper Mag. Canada* 53, No. 12: 109–119 (Nov. 1952).
2. Steenberg, B., *Svensk Papperstidn.* 771–778 (Oct. 1, 1953); *World Paper Trade Rev.* (Tech. Com. no. 10–22 (Nov. 1953)).

Received Sept. 15, 1953. Presented at the 7th Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry, Houston Tex., Nov. 18–20, 1953.

Local Section Meetings

The first meetings of several Local Sections will feature speakers of international reputation who will be in the United States at the time to participate in the TAPPI Fundamental Research Conference to be held in Appleton, Wis., in September.

Pacific: Seminar to be held at Portland, Ore., and Seattle, Wash., during the week of Sept. 27, 1954. H. F. Rance of Wiggins Teape Group Research Organization, High Wycombe, Bucks, England.

Lake States: Appleton, Wis., Sept. 23, 1954. Borje Steenberg, Swedish Forest Products Research Laboratory, Stockholm, Sweden.

Delaware Valley: Engineers Club, Philadelphia, Pa., Sept. 16, 1954. Alfred H. Nisson, Department of Textile Industries, The University, Leeds, England.

Kalamazoo Valley: Hotel Harris, Kalamazoo, Mich., Sept. 30, 1954. Dr. Nisson.

Ohio: Manchester Hotel, Middletown, Ohio, Sept. 16, 1954. W. Brecht, Technische Hochschule, Darmstadt, Germany.

Maine-New Hampshire: Madawaska Inn, Edmundston, N. B., Canada, Sept. 10, 1954. Dr. Nisson will discuss "An Analytical Approach to the Problem of Multi-cylinder Drying."

Southeastern: Valdosta, Ga., Oct. 1, 1954. Dr. Steenberg.

New England: Berkshire Inn, Great Barrington, Mass.

Fundamentals of the Paper Machine

The Fundamental Research Committees of TAPPI and the CPPA Technical Section are sponsoring a joint extended meeting of the respective committees at The Institute of Paper Chemistry, Appleton, Wis., on Sept. 21–24, 1954. The subject of the meeting deals with the fundamentals of the paper machine. *Registrations are limited to 200;* they will close on August 15 or when the limit has been reached. *Registrations will not be accepted at the time of the meeting.* Address all inquiries with reference to registration to Harry F. Lewis, The Institute of Paper Chemistry, Appleton, Wis.

The symposium will have for its objective the preparation for publication of a series of related papers and discussions dealing with the announced subject. This material will be made available to all members of the two associations.

The final program of the meeting is as follows:

September 20, 1954

10:00 a.m. to 5:00 p.m. Registration and tours of The Institute of Paper Chemistry. Arrangements can be made for informal group or committee meetings.

September 21, 1954

9:00 a.m. Addresses of Welcome by the committee chairmen: K. C. Logan, Northeastern Paper Products, Ltd., Quebec, P. Q., and Harry F. Lewis, Institute of Paper Chemistry, Appleton, Wis.

"Flow in Fiber Suspensions and the Effect of Turbulence," by J. A. Van den Akker, Institute of Paper Chemistry, Appleton, Wis.

"Fiber Motion and Flocculation," by S. G. Mason, Pulp and Paper Research Institute of Canada, Montreal, P. Q.

"The Hydrodynamics of the Headbox and Slice," by W. van der Meer, Van Gelder Zonen, N. V., Velsen Holland.

1:30 p.m. "Model Experiments of Sheet Formation on the Cylinder Wire," by Borje Steenberg, Jan Bergstrom, and R. I. Kjensjord, Swedish Forest Products Laboratory, Stockholm, Sweden.

"The Evaluation of Paper Machine Stock Systems by Basis Weight Analysis," by George Burkhard and Peter E. Wrist, Quebec North Paper Co., Baie Comeau, P. Q.

3:00 p.m. Panel discussion on the above papers.

September 22, 1954

9:00 a.m. "Filtration Resistance of Pulp Slurries," by Roy P. Whitney and William Ingmanson, Institute of Paper Chemistry, Appleton, Wis.

"Quantitative Studies of Water Removal by Table Rolls," by W. E. Bennett, British Paper & Board Research Association, Kenley, Surrey, England.

"Influence of Differential Speeds Between Stock and Wire on Sheet Properties," by A. Anderson, Swedish Forest Products Research Laboratory, Stockholm, Sweden.

11:30 p.m. "Stroboscopic Observations of the Wet End," by C. C. Porter, Southland Paper Mills, Lufkin, Tex.

"Water Removal and Two-Sidedness," by George F. Underhay, Bowaters Development and Research Ltd., London, England.

3:00 p.m. Panel discussion on the above papers.

September 23, 1954

9:00 a.m. "Fiber Properties and Fiber-Water Relationships in Relation to the Strength and Rheology of Wet-Webs," by Wilfred Gallay, The E. B. Eddy Co., Hull, P. Q.

"The Functions of the Felt in Water Removal on the Papermaking Machine," by Alfred H. Nisson, Department of Textile Industries, The University, Leeds, England.

"Laboratory Investigation of Water Removal by a Dynamic Suction Box," by Lars Nordman, Central Laboratory of the Finnish Pulp and Paper Industries, Helsinki, Finland.

1:30 p.m. "The Effect of Wet Pressing on Sheet Properties," by D. J. MacLaurin, Institute of Paper Chemistry, Appleton, Wis.

3:00 p.m. Discussion of the above papers.

September 24, 1954

9:00 a.m. "Measurement of Draws and Machine Speed Variations," by Dalton L. Shinn, Crown Zellerbach Corp., Camas, Wash.

"Introduction of Strains into the Sheet on Drying," by Bertil Ivarsson, Swedish Forest Products Research Laboratory, Stockholm, Sweden.

"Effect of Water Removal on Sheet Properties:

The Water-Evaporation Phase," by H. F. Rance, Wiggins Teape Group Research Organization, High Wycombe, Bucks, England.

1:30 p.m. "Elastic Theory of Nips with Practical Applications," by Homer E. Mahnstrom, Kimberly-Clark Corp., Neenah, Wis., and John P. Nash, University of Illinois, Urbana, Ill.

3:00 p.m. Panel discussion of the above papers.

Eighth Alkaline Pulping Conference

The Eighth TAPPI Alkaline Pulping Conference will be held at the Dinkler-Tutwiler Hotel, Birmingham, Ala., on Oct. 6–8, 1954.

The meeting will feature visits to the mills of the Coosa River Paper Co., Coosa Pines, Ala., and the Gulf States Paper Co., Tuscaloosa, Ala.

The following papers have been scheduled in the discussion of kraft cooking:

1. "Sulphidity in Southern Pine Kraft Pulp," by K. G. Chesley and P. L. Gilmont, The Crossett Co., Crossett, Ark.
2. "Instrumentation in the Cooking Process," by Fred Keyes, North Carolina Pulp Co., Plymouth, N. C.
3. "Reuse of Knots and Shives for Bleached Kraft," by Albert L. Wiley, Reigel Carolina Corp., Acme, N. C.
4. "Modified Permanganate Number for Partially Bleached Pulps," by Charles S. Benz, Scott Paper Co., Chester, Pa.
5. "Utilization of Kraft Knotter Rejects," by R. E. Miller, J. J. Owen, Jr., and J. M. Piette, Union Bag & Paper Corp., Savannah, Ga.
6. "Direct vs. Indirect Cooking for Pine and Hardwood Kraft Pulps," by Owen Hunter and Hansel Wade, Brunswick Pulp & Paper Co., Brunswick, Ga.
7. "Correlation Between Chlorine Number and Lignin Content of High Yield Kraft Pulps," by E. L. Keller, Forest Products Laboratory, and Peter B. Borlew, Container Corp. of America, Fernandina, Fla.

Discussion programs are being arranged on the following subjects:

1. The Effect of Quality and Size of Chips.
2. The Effect of Cooking Liquors: Time, Temperature, and Concentrations.
3. Chips Packing, Mechanical and Steam.
4. Blowing and Blow Valves.
5. Steaming: Automatic, Indirect, etc.
6. Continuous Cooking.
7. High Yield Kraft.
8. Effect of Sulphidity.
9. Preparation of High Yield Pulp for Washing.
10. Handling of Pulp from Blow Pits.
11. Instrumentation in the Cooking Process.
12. Va-Purge Process.
13. Injection Cooking.
14. Recooking of Knots.

Individuals who may wish to prepare brief papers on any of the above papers should communicate with H. Y. Charbonnier, Union Bag & Paper Co., Savannah, Ga.

Fifth Testing Conference

The Fifth Testing Conference will be held at the Biltmore Hotel, Dayton, Ohio, on Oct. 6–8, 1954.

The theme of the conference is "New Developments in Testing Methods and Techniques" and will feature short papers by several speakers. Both physical and chemical testing will be discussed.

In addition to the program in which papers will be presented there will be meetings of wax testing, paper testing, packaging materials testing, container testing, chemical methods, nonfibrous materials testing, pulp testing, optical properties, and microscopy committees. Members of the Technical Association interested in the work of any of these committees are welcome to attend.

Arrangements are being made to visit the plants of the McCall Corp. and the National Cash Register Co. on Friday afternoon, October 8.

On Thursday evening, October 7, the TAPPI Ohio Section will hold its second monthly meeting at the Dayton-Biltmore and will welcome individuals attending the Testing Conference.

The final program of the Testing Conference will be printed in the September issue of *Tappi*.

Room reservations should be made without delay at the Hotel Biltmore, Dayton, Ohio. Mention should be made of the TAPPI Testing Conference.

Austrian Meeting

"Wood Hydrolysis" will be the subject to be discussed at a meeting to be held at the Institute of Pulp and Paper Technology, Graez, Austria, on Oct. 15–16, 1954.

Prof. E. Hagglund of Stockholm, Sweden, will read a paper on the basis and development of wood hydrolysis and wood saccharification.

K. Schoenemann of Darmstadt, Germany, will lecture on the present stage of the technology of wood hydrolysis.

Several world authorities, including Fritz Brauns of The Institute of Paper Chemistry, Appleton, Wis., will be present to discuss these subjects.

Ninth Engineering Conference

The Ninth TAPPI Engineering Conference will be held at the Benjamin Franklin Hotel, Philadelphia, Pa., on Oct. 18–20, 1954.

Registration will start on Sunday, October 17, from 4 to 10 p.m.

Monday, October 18, 1954

8:30 a.m. Registration (Franklin Room)

9:15 a.m. General Session (Crystal Ball Room)

C. J. Sibler, West Virginia Pulp & Paper Co., New York, N. Y., will give the opening remarks.

9:30 a.m. Mill Planning and Economics Session (Crystal Ball Room)

R. A. Packard, Hopkinton, Mass., *Chairman*

"Paper Mill Rehabilitation Involving Rebuilding Old Paper Machines vs. New Paper Machines," by Harold G. Ingraham, Chas. T. Main, Inc., Boston, Mass.

"Methods of Preparing and Presenting Requests for Project Approval," by Earl K. Murphy, Rayonier, Inc., New York, N. Y.

10:45 a.m. Steam and Power Session (Crystal Ball Room)

W. M. Wyburn, Federal Paper Board Co., Inc., Bogota, N. J., *Chairman*

"Bark Burning in Paper Mill Power Plants," by Harold Hanson, Champion Paper & Fibre Co., Canton, N. C., and Louis Copian, Riley Stoker Co., Worcester, Mass.

"Outdoor Power Plants," by J. R. Chapman, Stone & Webster Engineering Corp., Boston, Mass.

12:30 p.m. Engineering Division Luncheons

Electrical Engineering Committee (Room 206)

Engineering Research and Machine Design Committee (Room 252)

Materials Handling and Industrial Engineering Committees (Room 244)

Mill Maintenance and Materials Committee (Room 210)

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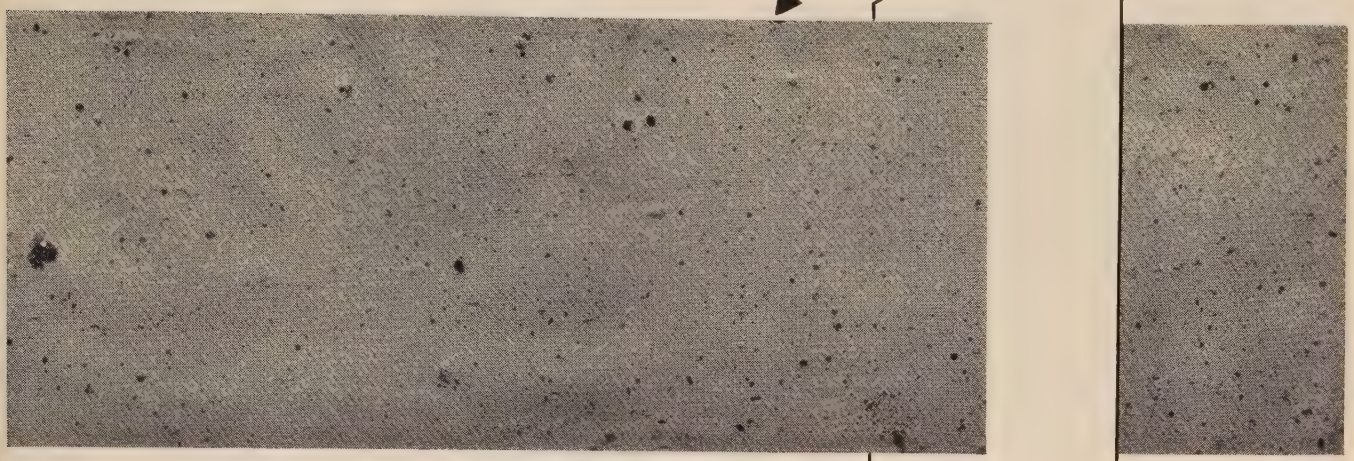

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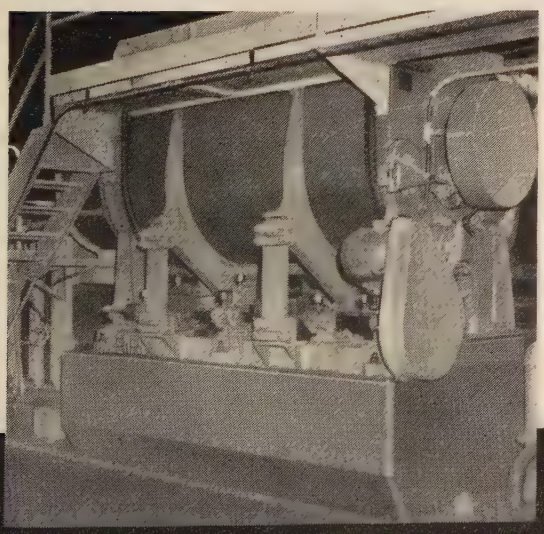

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2:00 p.m. Digester Corrosion Session (Crystal Ball Room)

J. R. Lientz, Union Bag & Paper Corp., Savannah, Ga., *Chairman*, and N. Shoumatoff, West Virginia Pulp & Paper Co., New York, N. Y., *Co-chairman*

"Identification of Surface Conditions in Digesters," by L. A. de la Grange, West Virginia Pulp & Paper Co., New York, N. Y.

"Review of Digester Corrosion Causes," by W. B. Parker, Hartford Steam Boiler Inspection and Insurance Co., Hartford, Conn.

"Comparative Analysis of Digester Corrosion Measurements—Summary Report No. 2," by H. O. Teeple, International Nickel Co., New York, N. Y., and N. Shoumatoff.

3:45 p.m. Discussion Meetings

Mill Planning and Economics (*Foyer Room*)

Panel Discussion—"Paper Mill Rehabilitation Involving Rebuilding Old Machines vs. New Machines." Panel members:

Sverre H. Grimnes, Diamond Match Co., Plattsburg, N. Y.
Allan Hyer, Bagley & Sewall Co., Watertown, N. Y.
Harold G. Ingraham, Chas. T. Main, Inc., Boston, Mass.
Roland Packard, Consultant, Hopkinton, Mass.
Russell G. Seip, St. Regis Paper Co., Pensacola, Fla.

Steam & Power (*Betsy Ross Room*)

Panel Discussion—"Slagging Problems in Furnaces and Superheaters." Panel members:

E. H. Domley, Babcock & Wilcox Co., New York, N. Y.
D. C. Edminston, Southland Paper Mills, Lufkin, Tex.
R. V. Knapp, Mosinee Paper Mills Co., Mosinee, Wis.
N. H. Mailhos, Brunswick Pulp & Paper Co., Brunswick, Ga.
V. P. Owens, Combustion Engineering-Superheater, Inc., New York, N. Y.
H. B. Wallace, Jr., Foster-Wheeler Corp., New York, N. Y.
W. M. Wyburn, Moderator

Digester Corrosion (*Crystal Ball Room*)

Discussion of session papers.

Dinner (where you will)

Tuesday, October 19, 1954

9:00 a.m. Electrical Engineering Session (Crystal Ball Room)

R. W. Foster, Champion Paper & Fibre Co., Canton, N. C., *Chairman*

"Application and Design Characteristics of A-C Motor Control," by R. W. Foster.

"The Selection of Chipper Drives," by M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn.

10:30 a.m. Materials Handling and Industrial Engineering Session (Crystal Ball Room)

W. R. McNally, Link-Belt Co., Pittsburgh, Pa., *Chairman*, and J. M. MacBrayne, Union Bag & Paper Corp., Savannah, Ga., *Co-Chairman*

"The Scope of Industrial Engineering in the Pulp and Paper and Allied Industries," by J. M. MacBrayne.

"Wood Room Refuse Fuel Handling," by George McGregor, Minnesota & Ontario Paper Co., International Falls, Minn.

"The Application of Industrial Trucks in the Pulp and Paper Industry," by Lee Cirello, Towmotor Corp., Cleveland, Ohio.

12:30 p.m. Engineering Division Luncheons

Chemical Engineering Committee (Room 206)
Drying and Ventilating Committee (Room 210)
Hydraulics Committee (Room 244)
Mill Planning and Economics Committee (Room 230)
Steam and Power Committee (Room 252)

2:00 p.m. Engineering Research and Machine Design Session (Crystal Ball Room)

R. G. Quinn, Johns-Manville Research Corp., Manville, N. J., *Chairman*

"Noise Control in Paper Mills and Converting Plants," by M. N. Davis, Kimberly-Clark, Corp., Neenah, Wis.

"Vibration Measurement and Roll Balancing with the Vibration," by James T. Roberts, International Research & Development Corp., Columbus, Ohio.

"Test Data on Drier Bearing Friction," by L. H. Moore, The Black-Clawson Co., Hamilton, Ohio.

3:45 p.m. Discussion Meetings

Electrical Engineering (*Betsy Ross Room*)

"Power Requirements of Supercalenders," by J. L. Van Nort, Reliance Electric and Engineering Co., Cleveland, Ohio.

"Results of Down Time Investigation of Electric Drives," by R. F. Sorenson, Union Bag & Paper Corp., Savannah, Ga.

Materials Handling and Industrial Engineering (*Foyer Room*)

Discussion of session papers.

Engineering Research and Machine Design (*Crystal Ball Room*)

Discussion of session papers.

3:30 p.m. Data Sheets Committee (Independence Room)

6:00 p.m. Social Hour (Betsy Ross, Independence, Lafayette, Franklin Room, and Gallery)

7:00 p.m. Dinner (Crystal Ball Room)

W. D. Harrison, Riegel Paper Corp., Milford, N. J., *Toastmaster*

"We're Working While Rome Burns," by James Q. du Pont, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

Wednesday, October 20, 1954

9:00 a.m. Mill Maintenance and Materials Session (Crystal Ball Room)

Hubert F. Parker, New York & Pennsylvania Co., Lock Haven, Pa., *Chairman*

"Instrumentation," by E. Kehoe, Marinette Paper Co., Marinette, Wis.

"Coordination of Instrumentation Engineering with Mill Operations," by J. R. Upson, Union Bag & Paper Corp., Savannah, Ga.

10:45 a.m. Drying and Ventilating Session (Crystal Ball Room)

Curt A. Young, Riegel Paper Corp., Milford, N. J., *Chairman*

"The Application of a Suction Hot Press in the Drier Section of a Paper Machine," by J. C. Harper, Downingtown Manufacturing Co., Downingtown, Pa.

"Calender Cooling Systems on the Modern Paper Machines," by L. G. Janett, J. O. Ross Engineering Corp., Chicago, Ill.

12:30 p.m. Engineering Division Luncheon

Charles J. Sibler, *Toastmaster*

Speaker—H. W. Prentis, Jr., Chairman of the Board, Armstrong Cork Co., Lancaster, Pa.

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Weyerhauser Timber
Consolidated W. P. & Paper
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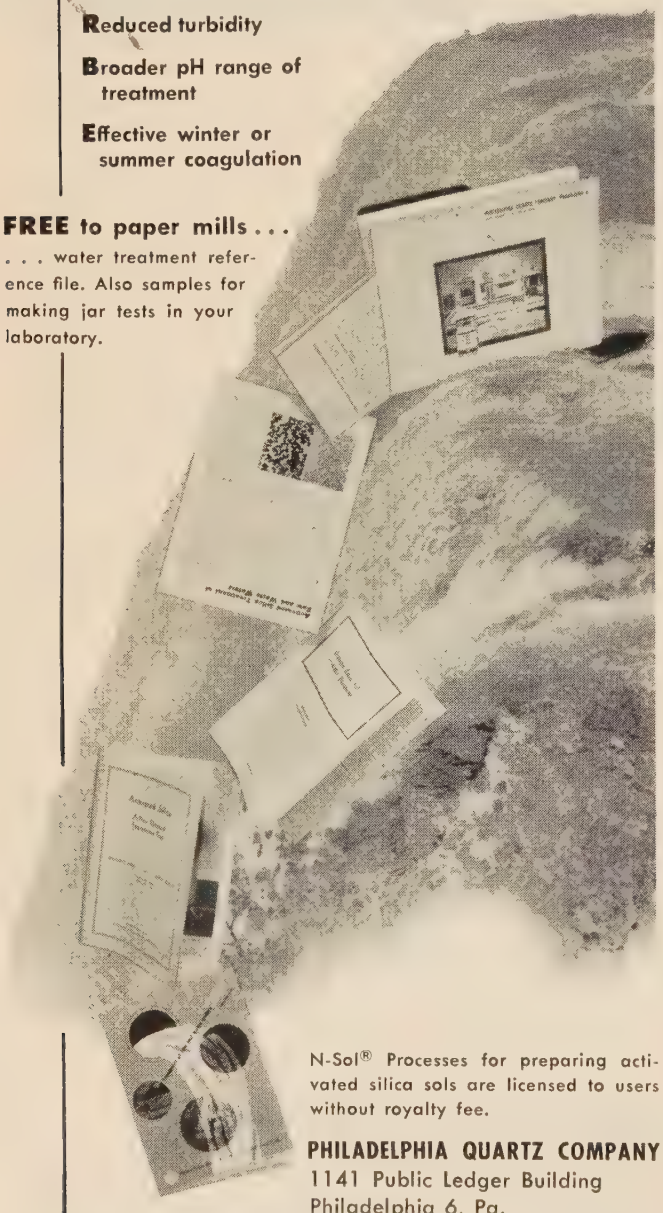

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2:30 p. m. HYDRAULICS SESSION (*Betsy Ross Room*)
K. J. MACKENZIE, Eastman Kodak Co., Rochester, N. Y., *Chairman*

"Friction Loss of Paper Stock in Pipes," by Richard E. Durst, University of Maine, Orono, Me.

3:45 p.m. DISCUSSION MEETINGS

Mill Maintenance and Materials (*Franklin Room*)

"How Maintenance Handles Spare Parts," by Keith Martiny, Kimberly-Clark Corp., Neenah, Wis.

Drying and Ventilating (*Foyer Room*)

Panel Discussion of papers presented. Panel members:

M. J. Barker, Beckett Paper Co., Hamilton, Ohio
A. J. Cirrito, Rice Barton Corp., Worcester, Mass.
R. M. Cook, Midwest-Fulton Machine Co., Dayton, Ohio
E. G. Drew, Drew Engineering Co., Portland, Ore.
J. C. Harper, Downingtown Mfg. Co., Downingtown, Pa.
L. G. Janett, J. O. Ross Eng. Corp., Chicago, Ill.
J. M. McAlear, Mason-Neilan Regulator Co., Boston, Mass.
C. A. Young, Reigel Paper Corp., Milford, N. J., Moderator

Hydraulics (*Betsy Ross Room*)

Discussion of session paper.

7:00 p.m. DINNER MEETING FOR COMMITTEE CHAIRMEN AND SECRETARIES

Review of Ninth Engineering Conference
Discussion of 1955 Conference
Review of Engineering Division Projects
TAPPI Engineering Data Sheets

Thursday, October 21, 1954

9:00 a.m. PLANT VISITS: Scott Paper Co., Chester, Pa., General Electric Co., and Westinghouse Electric Corp., Philadelphia, Pa.

1955 Coating Conference

Dates for the sixth TAPPI Coating Conference, to be held at Cleveland, Ohio, have been set for May, 1955. The conference, which was previously announced for the Fall of 1955, will be held in May to avoid conflicts that would have arisen in connection with the Fall dates.

Corrugated Container Conference

The TAPPI Fourth Corrugated Container Conference will be held at the General Oglethorpe Hotel, Savannah, Ga., on Nov. 17–19, 1954.

The morning session on November 17 will deal with liner board. Kraft and jute board will be considered. In addition a paper will be presented on the handling and storage of roll stock.

The afternoon session will consist of papers giving the manufacturers' and converters' viewpoints on various corrugating media. In addition there will be papers on corrugator adhesive formulations necessary to combine the different types of liner board and media. Both starch and silicate will be considered.

The evening session will consist of three discussion meetings running simultaneously. The subjects to be discussed are: "Moisture in Medium and Liner Board," Checking or Cracking of Outer Liner," and "Finish of Liner Board."

On November 18 there will be visits to the mills of the Union Bag & Paper Corp. in Savannah, Ga., and the Southern Paperboard Co. in Port Wentworth, Ga.

On November 19 the corrugator plants of the International Paper Co., Georgetown, S. C., The National Container Corp., Jacksonville, Fla., and the Gaylord Container Corp., Atlanta, Ga., will maintain open-house for plant visits by individuals who may wish to make such visits.

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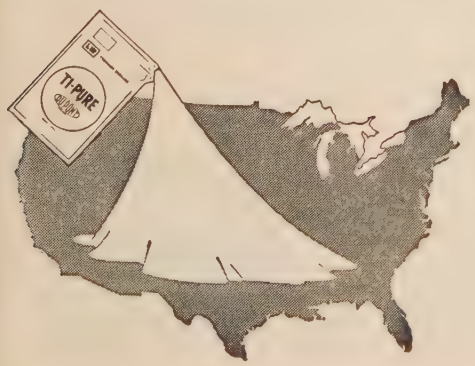

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PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

George F. Ackerman, Technical Director, Kieckhefer Container Co., Delair, N. J. Attended Columbia University.

Vincenzo Amici, Technical Director, Ente Nazionale per la Cellulosa e per la Carta, Rome, Italy, a 1931 graduate of Rome Engineering and Chemical University with an Eng.D. degree.

Kaarlo V. Amperla, Technical Director, Companhia Portuguesa de Celulose, Cacia, Portugal, a 1927 graduate of the Technical University of Helsinki.

William C. Atkin, Area Manager, Dowell, Inc., Charlotte, N. C., a 1940 graduate of Michigan State College.

Otis L. Calhoun, Electrical Superintendent, Crossett Paper Mills, Crossett, Ark. Attended Louisiana Polytechnic Institute.

Frank L. Cessna, Jr., Student, New York State College of Forestry, Syracuse, N. Y.

Stuart M. Chapman, Supervisor, Printability Research, Pulp and Paper Research Institute of Canada, Montreal, P. Q., Canada, a 1936 graduate of McGill University.

Ernest D. Childers, Jr., Chemical Engineer, Bowaters Southern Paper Corp., Calhoun, Tenn., a 1952 graduate of New Berry College.

Rosaire Coutu, Mill Chemist, Rolland Paper Co., St. Jerome, P. Q., Canada, a 1914 graduate of the University of Montreal.

John K. Craver, Manager, Development Dept., Monsanto Chemical Co., St. Louis, Mo., a 1937 graduate of Southern Illinois University.

Charles M. Crow, Coating Superintendent, The Mead Corp., Chillicothe, Ohio.

Charles M. Daggett, Salesman, Corn Products Sales Co., Cleveland, Ohio.

Vittorio de Nora, Technical Adviser, Oronzio de Nora, Milan, Italy, a 1934 graduate of Politecnico Milano with an Eng.D. degree, and a 1938 graduate of Lehigh University with a Ph.D. degree.

Jorge J. Dujan, Chief of Pulp Production, Papelera "Rio Parana S. A.," Buenos Aires, Argentina, a 1947 graduate of the National University of "La Plata" with an Eng.D. degree.

Frank T. Edman, Technical Supervisor, International Paper Co., Palmer, N. Y., a 1950 graduate of Yale University.

Roger P. Forrestal, Engineering Supervisor, Cutler Hammer, Inc., Milwaukee, Wis., a 1934 graduate of Marquette University.

Leo P. Gebo, Production Manager, Thos. Phillips Co., Akron, Ohio.

Frank H. Glass, Plant Engineer, Green Bay Box Co., Green Bay, Wis., a 1951 graduate of Purdue University.

Robert D. Glidden, Director of Paper Operations, Personal Products Corp., Milltown, N. J., a 1939 graduate of the University of Pennsylvania.

Victor T. Grabar, Sales-Service Director, St. Regis Paper Co., Tacoma, Wash., a 1948 graduate of the College of Puget Sound.

Fred Gram, Technical Manager, A. Ahlstrom Osakeyhtio, Kauttus, Finland, a 1945 graduate of Abo Akademi.

Margaret Haferd, Librarian, United States Information Center, London, England.

Willard E. Hahn, Vice-President, Multiwall Bag Div. and Resident General Manager, Kraft Div., St. Regis Paper Co., Pensacola, Fla.

Gerald W. Hamilton, Research Chemist, Hollingsworth & Vose Co., East Walpole, Mass., a 1947 graduate of Lake Forest College.

Herbert S. Heide, Associate Technical Officer, Paper Laboratory, S. A. Bureau of Standards, Pretoria, S. A. a 1936 graduate of Staatliohe Hochschule fur Angewandte Technik, Kothen, Anhalt.

Howard C. Hillock, Office Manager, Alliance Paper Mills Ltd., Georgetown, Ont., Canada.

Paul R. Illner, Group Leader, The Champion Paper & Fibre Co., Hamilton, Ohio, a 1936 graduate of Miami University.

Edward B. Isett, Manager, Paper Div., The Curtis Publishing Co., Philadelphia, Pa. Attended Franklin & Marshall College.

Samuel O. Jones, Director of Chemical Engineering, R. J. Reynolds Tobacco Co., Research Dept., Winston-Salem, N. C., a 1932 graduate of North Carolina State College with a Ph.D. degree from Johns Hopkins University in 1936.

Robert L. Knorr, Chemist, The Dow Chemical Co., Midland, Mich., a 1948 graduate of the University of Delaware.

John W. Leach, Senior Field Engineer, Imperial Oil Ltd., Toronto, Ont., Canada, a 1927 graduate of the University of Saskatchewan.

George P. Loomis, Jr., Sales Engineer, Reliance Electric & Engineering Co., Syracuse, N. Y., a 1949 graduate of Massachusetts Institute of Technology.

Richard M. Ludwig, Assistant Project Engineer, Paper Mill Design, The Rust Engineering Co., Birmingham, Ala., a 1952 graduate of the University of Maine.

Fritz A. Maier, Chemical Engineer, West Virginia Pulp & Paper Co., Mechanicville, N. Y., a 1954 graduate of the New York State College of Forestry.

Williem M. Mazer, Research Chemist, Koninklijke-Shell Laboratorium, Amsterdam, The Netherlands, a 1935 graduate of the University of Amsterdam with a Ph.D. degree.

Sylvia Mechanic, Central Service, Brooklyn Public Library, Brooklyn, N. Y.

Henry B. Mitchell, Vice-President and Secretary, Kraft Equipment Co., Inc., Savannah, Ga., a 1932 graduate of Massachusetts Institute of Technology and a 1936 graduate of Harvard University.

William A. Moggio, Resident Engineer, Southern Region, National Council for Stream Improvement, New York, N. Y., a 1939 graduate of Rutgers University.

James M. Pepper, Associate Professor of Chemistry, University of Saskatchewan, Saskatoon, Sask., Canada, a 1943 graduate of McGill University with a Ph.D. degree.

Richard A. Rivers, Assistant Director of Technical Service, St. Regis Paper Co., Deferiet, N. Y., a 1948 graduate of Clarkson College.

David F. Roberts, Plant Engineer, St. Regis Paper Co., Jacksonville, Fla., a 1936 graduate of the University of Delaware.

Jose A. Ruiz (Duarte), Assistant General Manager, Fibracel, S. A., Mexico, D. F., Mexico, a 1946 graduate of the National University of Mexico.

Joseph H. Shumka, Development Engineer, MacMillan & Bloedel Ltd., Nanaimo, B. C., Canada, a 1950 graduate of the University of British Columbia.

Rolland F. Sultze, Jr., Student, Institute of Paper Chemistry, Appleton, Wis., a 1951 graduate of Yale University.

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John H. Treadwell, Secretary-Treasurer, Treadwell Supply Co., Inc., Watertown, N. Y.

Clarence W. Van Orman, Production Supervisor, S. D. Warren Co., Cumberland Mills, Me., a 1948 graduate of New York State College of Forestry.

Frank Vokes, Waste Control Engineer, Champion Paper & Fibre Co., Canton, N. C., a 1949 graduate of New York State College of Forestry.

Barrett L. Walker, Industrial Engineer, Wortendyke Div., Camp Mfg. Co., Inc., Richmond, Va., a 1951 graduate of Georgia Institute of Technology.

Howard A. Whittum, Chief Chemist, Advance Coatings Co., Westminster, Mass., a 1934 graduate of Worcester Polytechnic Institute.

Eugene H. Williams, Chemical Engineer, Detroit Sulphite Pulp & Paper Co., Detroit, Mich., a 1934 graduate of North Carolina State College.

Howard B. Wilson, Sales Engineer, The Pusey & Jones Corp., Wilmington, Del., a 1947 graduate of the University of Delaware.

Kurt H. Wohl, Technical Service Engineer, Stein, Hall & Co., Inc., New York, N. Y., a 1949 graduate of the University of Cincinnati.

Thomas J. Ziolkowski, Chemist, Marathon Corp., Rothschild, Wis., a 1951 graduate of Northland College with a Ph.D. degree.

Hyman W. Zussman, Sales Manager, Alrose Chemical Co. Div., Geigy Chemical Corp., Providence, R. I., a 1936 graduate of Harvard University.

TAPPI Notes

Hanns F. Arledter is now Director of Research of the Hurlbut Paper Co., South Lee, Mass.

Anders P. Arlov, formerly of the Pulp and Paper Research Institute of Canada, is now with A/S Borregaard, Sarpaborg, Norway.

Robert A. Baum, formerly of Bulkley, Dunton Processes, Inc., is now President of Pacific Industrial Engineers, Inc., Pasadena, Calif.

John O. Burton is now Assistant Director of Research of the Minnesota & Ontario Paper Co., International Falls, Minn.

William P. Campbell, formerly of the Hercules Powder Co., is now Research Supervisor for Rohm & Haas Co., Philadelphia, Pa.

Robert F. Caswell, Jr., formerly student at the New York State College of Forestry, is now Chemical Engineer, Central Technical Dept., St. Regis Paper Co., Deferiet, N. Y.

Roy C. Charron of the United States Envelope Co. is now Director of the Laboratory, Metuchen, N. J.

George T. Clayton, formerly of the Moore & White Co., is now Sales and Service Engineer for the Wisconsin Wire Works, Pensacola, Fla.

Owen M. Cornell is now Manager of the West Coast Paper Chemicals Dept., American Cyanamid Co., Portland, Ore.

Robert R. Crawford is now General Manager of Black-Clawson International, Ltd., London, England.

Frederick S. Crysler is now Vice-President of the Container Corp. of America, Manayunk, Pa.

William R. Csellak is now Staff Assistant to the Vice-President in Charge of Operations, Gardner Board & Carton Co., Middletown, Ohio.

L. C. Currier is now Vice-President in Charge of Development and Engineering, Sorg Paper Co., Middletown, Ohio.

Harry G. Davis is now General Superintendent of the Maine Coated Div., Oxford Paper Co., Rumford, Me.

Robert M. Drummond is now Assistant Director of Research, Research Div., International Paper Co., Glens Falls, N. Y.

Clarence L. Durkee, formerly of the D. J. Murray Co., is now with Medura Corp., Wausau, Wis.

Fred C. Goodwill is now Manager of the St. Regis Paper Co., Bucksport, Me.

Burton E. Helberg, formerly of the Lion Oil Co., is now Pulp Plant Supervisor, American Viscose Corp., Marcus Hook, Pa.

Arne G. Hellstrom is now Assistant General Manager of Paper Machinery, Ltd., Montreal, Canada.

W. G. Hodgkins, Jr., is now Chemist for the Great Northern Paper Co., Millinocket, Me.

Harold N. Holcombe, formerly of Chronco Products Co., is now Chief of Quality and Technical Control for the Eastern Box Co., Baltimore, Md.

Paul W. Horeyseck, formerly of Uncasville, Conn., is now Manager of the American Coating Mills Div., Robert Gair Co., Inc., Middletown, Ohio.

H. E. Juers, formerly with Hydraulic Machinery Co., Ltd., is now Plant Engineer of the Anglo Newfoundland Development Co., Grand Falls, Nfld.

R. J. Kindl is now Project Engineer for the Rust Engineering Co., Birmingham, Ala.

Charles P. Kirchen is now Southern Sales Manager of Buckman Laboratories, Inc., Memphis, Tenn.

William A. Kraske, formerly of the Celanese Corp. of America, is now in the Development Dept. of Columbia Cellulose Co., Ltd., Prince Rupert, B. C., Canada.

Edward L. Lamb is now Production Assistant to the Executive Vice-President of the Minnesota & Ontario Paper Co., Minneapolis, Minn.

Howard J. Leech is now Chief Chemist for Paperboard of the Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.

James G. Long, formerly of the Pacific Paperboard Co., is now Shift Foreman for the Ketchikan Pulp Co., Ketchikan, Alaska.

Robert W. Long, formerly of Wabash Ind., is now General Manager of the Lakeshore Plant of the Container Corp. of America, Chicago, Ill.

Trygve C. Lukens, Jr., formerly student at the New York State College of Forestry, is now Chemist for the Riegel Paper Corp., Milford, N. J.

A. T. (Tom) Luey, formerly of the Sutherland Paper Co., is now executive secretary of the Boxboard Research & Development Assn., 33 No. La Salle St., Chicago 2, Ill.

W. A. Lunsford, formerly of the Hercules Powder Co., is now with the Consolidated Paper Co., Monroe, Mich.

Carl Magnus, formerly of the Moraine Paper Co., is now Vice-President of the Halltown Paper Board Co., Halltown, W. Va.

Fritz Maier, formerly student of the New York State College of Forestry, is now Chemical Engineer for the West Virginia Pulp & Paper Co., Mechanicville, N. Y.

Robert L. Martin, Chief of the Technical Library of the Quartermaster Research & Development Center, is now located at Natick, Mass.

Arthur E. May, formerly of the Moore & White Co., is now Engineer for Keasby & Mattison Co., Ambler, Pa.

Wm. V. McLeod, formerly of Hollingsworth & Whitney Co., is now Tour Foreman for Bowaters Southern Paper Corp., Calhoun, Tenn.

William H. McPherson is now Manager of the Research Laboratory, Minnesota & Ontario Paper Co., International Falls, Minn.

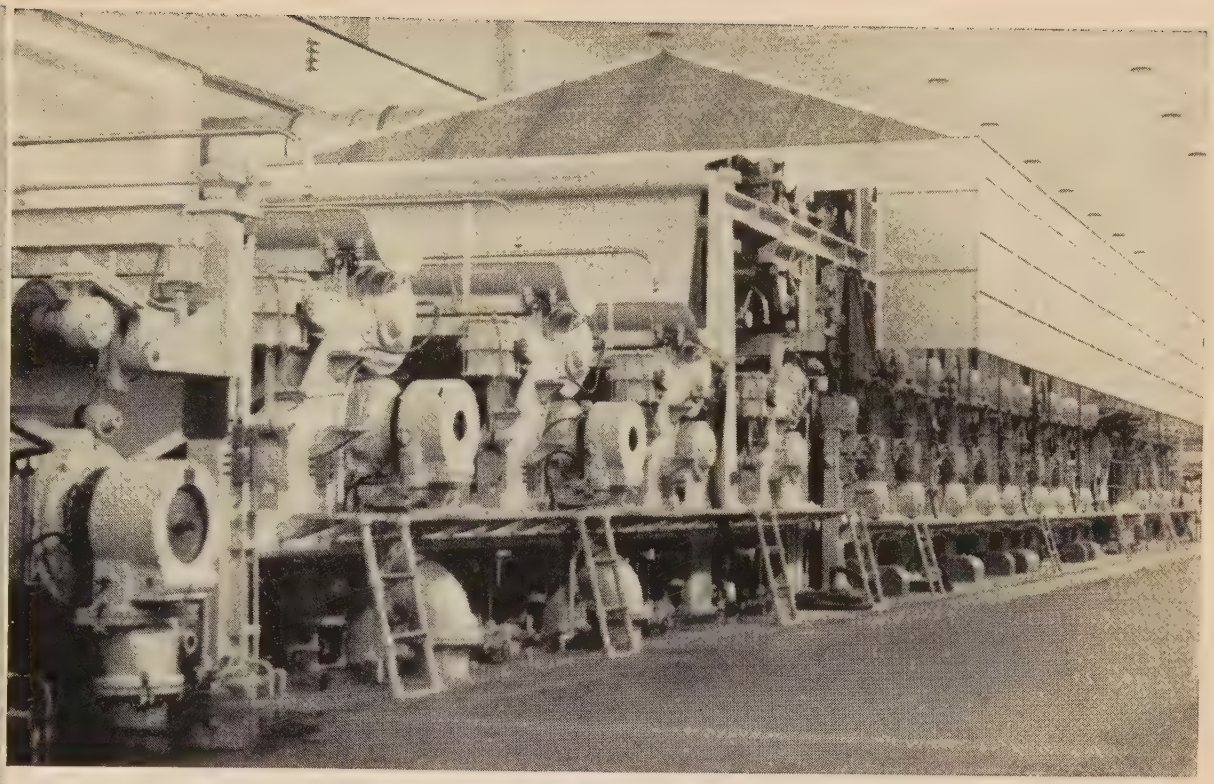
Harold R. Murdock has transferred his consulting firm from Tuscon, Ariz., to 310 S. Roswell Rd., N. E., Atlanta, Ga.

Henry A. Olsen, formerly of the Premoid Corp., is now Chemist for Bonded Fibers, Inc., Buena Vista, Va.

Howard H. Parker, Technical Service Engineer of the Paper Makers Chemical Div., Hercules Powder Co., has been transferred from Milwaukee, Wis., to Kalamazoo, Mich.

Frank T. Peterson is now Executive Vice-President and Chairman of the Executive Policy Committee of the Black-Clawson Co., New York, N. Y.

Noel R. Phillips, formerly of the Champion Paper & Fibre Co., is now Technical Director of the Riegel Carolina Corp., Acme, N. C.



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Finland Representative: **AKTIEBOLAGET EKSTROMS MASKINAFFAR, Helsingfors, Finland**

R. Byram Porter is now Technical Service Director of the Nopco Chemical Co., Harrison, N. J.

T. Richard Probst, formerly of the Oregon Pulp & Paper Co., is now Vice-President and Manager of Mills of the Eastern Corp., South Brewer, Me.

Robert J. Proctor is now General Manager of the West Jersey Paper & Mfg. Co., Camden, N. J.

Harry A. Raddin, formerly of Hofft Co., Inc., is now Vice-President of Miller Hofft, Inc., Richmond, Va.

John Robert is now Vice-President in Charge of Engineering of Globe Roofing Products Co., Inc., Whiting, Ind.

Kenneth A. Roe is now Vice-President of Burns & Roe, Inc., New York, N. Y.

W. P. Richardson is now Superintendent of the Insulated Board Mill, McAndrews & Forbes Co., Camden, N. J.

A. W. Rizzo is now Chief Engineer of the Container Corp. of America, Wabash, Ind.

Carl Rosenblum is now Technical Director of the Rose Ribbon & Carbon Mfg. Co., Inc., Harrison, N. J.

Samuel Rothenberg is now Research Assistant at the New York State College of Forestry, Syracuse, N. Y.

Hirochika Sakata, formerly of the Textile Research Institute of Japan, is now head of the research section, Toyo Pulp Co., Hiro-Machi, Kure-Shi, Japan.

Guy E. Sanford, formerly of the Goslin-Birmingham Mfg. Co., is now a Sales Chemical Engineer for Improved Machinery, Inc., Nashua, N. H.

Thomas J. Sargent, formerly student at the Lowell Technological Institute, is now Research Chemist for Crane & Co., Dalton, Mass.

Chester J. Schmidt, Vice-President in Charge of Sales for the J. O. Ross Engineering Corp., has been transferred from Detroit, Mich., to New York, N. Y.

Richard W. Scholl, formerly of Canton, N. C., has been transferred to Hamilton, Ohio, as Coordinator of Pulp Production.

Biswaneth Sen is now with the Titaghur Paper Mills, Titaghur, West Bengal, India.

Hugh C. Smith is now Superintendent of the Ink Dept., Kalamazoo Vegetable Parchment Co., Kalamazoo, Mich.

George W. Shaw is now Deputy Director of Operations of the Bowaters Corp., Ltd., London, England.

John F. Shea is now General Sales Manager of the Becco Sales Corp., Buffalo, N. Y.

Joseph W. Shimp, formerly of the Scott Paper Co., is now Plant Manager of the Marinette Paper Co., Fort Edward, N. Y.

Philip Sjogren is now General Manager of Elof Hansson, Gotborg, Sweden.

Edwin I. Stearns has been transferred from Bound Brook, N. J., to Chicago, Ill., as Assistant Sales Manager of the American Cyanamid Co.

Solomon Steinberg is now Research Engineer of the New York *Times*, New York, N. Y.

Frank L. Strand, formerly of the U. S. Gypsum Co., is now with the Gardner Board & Carton Co., Middletown, Ohio.

E. H. Stryker, formerly of Pabco Products, Inc., is now Consulting Engineer with Drisdale & Schedler, San Francisco, Calif.

Deon Sutton, formerly of Gaillet & Hartig Co., is now with Buckman Laboratories, Inc., Memphis, Tenn.

Leon F. Swec is now Technical Director of H. P. Smith Paper Co., Chicago, Ill.

Jacques F. Tasiaux is now Managing Director of Continental Cellulose, S. A., Brussels, Belgium.

E. B. Taylor, formerly of Stein, Hall & Co., is now with Taylor's Sporting Goods Co., Sarasota, Fla.

Harry G. Taylor is now Chief Chemist of Rayonier, Inc., Fernandina, Fla.

Inman D. Thorp is now Research Director for Paper Manufacturers Co., Philadelphia, Pa.

Warren L. Thompson is now Assistant Director of Research and Development for the Mid-Continent Petroleum Corp., Tulsa, Okla.

Henry J. Trolin is now Vice-President of Sitroux, Inc., New Hartford, N. Y.

Paul E. Trout, formerly of the American Box Board Co., is now Chief Chemist of Waldorf Paper Products Co., St. Paul, Minn.

Miss Carola Trittin is now Chief Chemist of Ward Paper Co., Merrill, Wis.

Arthur P. Wagenknecht of A. P. Wagenknecht Co. has moved his office from Pittsfield, Mass., to Thompsonville, Conn.

Charles L. Wagner is now Plant Manager of the Marathon Corp., Rothschild, Wis.

Roy R. Wiberg is now Project Engineer for the Pulp Div., Weyerhaeuser Timber Co., Longview, Wash.

Leonard W. Williams, formerly of Lukens Steel Co., is now Consultant for the Colorado Fuel & Iron Co., Wilmington, Del.

John C. Wollwage is now Director of Technical Research for the Kimberly-Clark Corp., Neenah, Wis.

J. Edward Vivian has transferred from Cambridge, Mass., to Bangor, Me., as director of the M.I.T. School of Chemical Engineering Practice.

Robert F. Vokes is now Vice-President of the Dilts Machine Works, Fulton, N. Y.

Edward A. Wodka is now Technical Assistant Superintendent of Paterson Parchment Paper Co., Bristol, Pa.

L. M. Woodside is now Chief Engineer, Technical Field Service of the Albany Felt Co., Albany, N. Y.

Everett S. Worth is now Chief Chemist of the Paterson Parchment Paper Co., Bristol, Pa.

Michael J. Yanulis is now Production Manager of the Hot Melt Div., Lowe Paper Co., Ridgefield, N. J.

Charles E. Young, formerly of West Linn, Ore., is now Assistant Superintendent of the Western Gummed & Coated Products Div., Crown Zellerbach Corp., North Portland, Ore.

Ward S. Yunker, formerly of the Sutherland Refiner Corp., is now Sales Engineer for E. D. Jones & Sons, Inc., Atlanta, Ga.

Frank Zeitlin, formerly of the West Virginia Pulp & Paper Co., is now Production Manager of Alton Box Board Co., Alton, Ill.

Edgar R. Zimmerman is now Paper Sales Representative of the Minnesota & Ontario Paper Co., Minneapolis, Minn.

Erich K. Zimmermann is now Assistant Technical Director of the National Lead Co. Research Laboratory, Brooklyn, N. Y.

* * *

Edgar Brothers Co. has merged with Attapulgus Minerals & Chemical Corp. to form the Minerals & Chemicals Corp. of America, Metuchen, N. J.

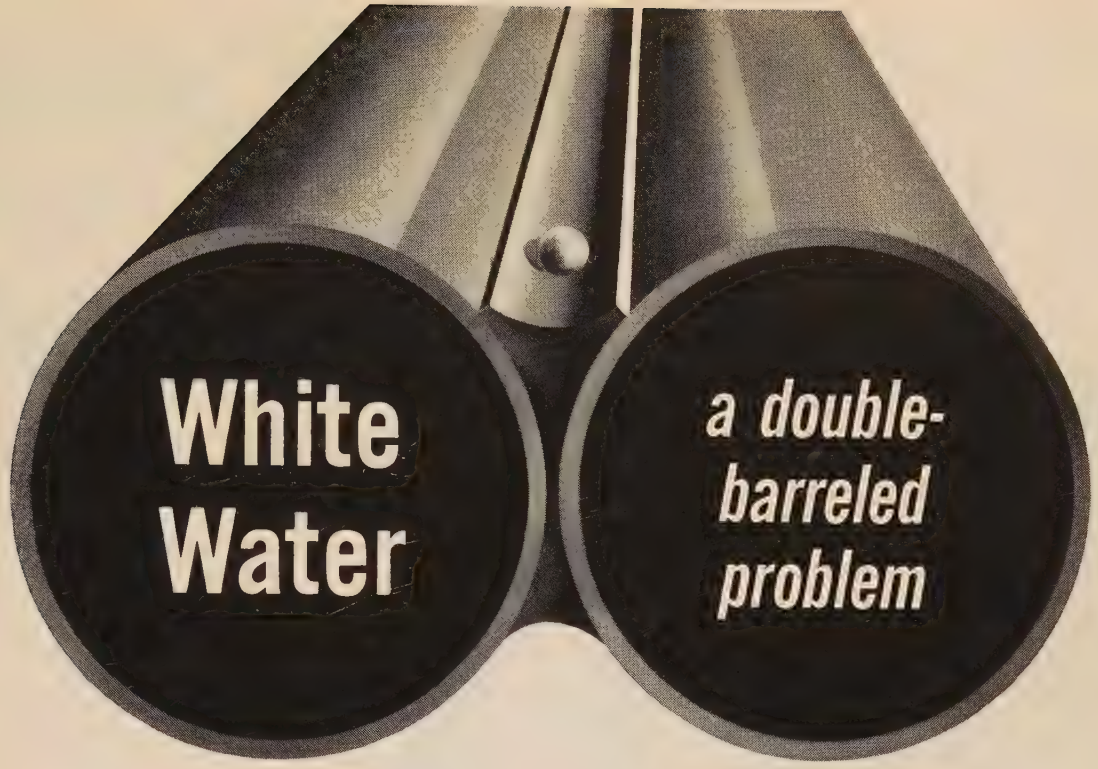
William D. Schaffer has succeeded *Merril E. Jordan* as the official representative in TAPPI of Godfrey L. Cabot, Inc., Cambridge, Mass.

J. S. Peacock, President of the Howard Publishing Co., has moved his eastern office to 60 E. 42nd St., New York 17, N. Y.

Industry Notes

PRODUCTION

In May, buoyed by a contraseasonal rise in the production of paperboard, total production for the month is estimated to have been 2,249,000 tons, 3% more than in April and within 1% of the output recorded in May, 1953. Also in May, the volume of new orders received exceeded that of the previous month and was, in fact, the largest volume received in a single month since last October. This, too, is attributed to a sharp rise in orders received by paperboard mills.



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The question, usually, is not what to do with white water, but what to do *about* it. Some mills have the problem of stream pollution; others the problem of water supply. Fortunately, Dicalite filtration answers both.

DISPOSAL If re-cycling is not required, filtration with Dicalite Filteraids yields a brilliantly clear effluent with no suspended solids to cause pollution.

RECLAMATION Filtered white water can be re-cycled, using a partially or entirely closed system. Dicalite filteraids remove all solids to give brilliantly clear water which is equal – often superior – to fresh water for most systems. Only a small percentage of fresh make-up water is needed daily. Water is saved and no disposal system is required.

IN EITHER CASE, you get still another advantage; practically 100% recovery of furnish components such as fibers, fillers and filteraid – all of which can be re-used to lower your furnish costs. Let us send you complete information on the many paper mill uses of

Dependable GREAT LAKES *Dicalite*® DIATOMACEOUS MATERIALS

DICALITE DIVISION, GREAT LAKES CARBON CORPORATION, 612 SOUTH FLOWER ST., LOS ANGELES 17, CALIFORNIA

The production of printing grades other than newsprint decreased slightly from the April level and is estimated to have been 294,000 tons. As in the instance of the preceding month, orders received, as 281,000 tons, trailed production and the backlog of orders on hand was reduced to 238,000 tons. This was about 24% less than at the same time last year and equal to about 20 days' production.

The output of fine papers advanced slightly over April and approximated that of a year ago as 112,000 tons were produced. The backlog of orders continued to be steady and at the close of the month was 55,000 tons, equivalent to about 12 days' production.

In the coarse paper group, production of 286,000 tons, although 10,000 tons more than in April, was about 2% less than in May of last year. For the year to the end of May, the manufacture of these papers was slightly more than 1% ahead of last year, but this is due to gains made early in the year, production for April and May running behind that of last year. The volume of orders received, at 276,000 tons, was virtually unchanged from April, but the tonnage represented by unshipped orders decreased slightly to 113,000 tons, equal to 9 days' production at the current level.

The production of tissue papers, which has consistently exceeded that of last year, continued to do so as 134,000 tons were manufactured. For the first 5 months the output of these papers has exceeded that of last year by about 8%.

The manufacture of newsprint, as in the instance of tissue paper, also has regularly run ahead of last year, and at the end of 5 months was 465,000 tons, 6% more than for the same period of last year.

As previously indicated the month of May was marked by a distinct improvement in the paperboard sector, production rising to an estimated 1,044,000 tons. Further, despite the fact that output was high, it was exceeded by the receipt of new orders totaling 1,073,000 tons. As a result the backlog of orders increased to 371,000 tons, but was still 20% less than at the same time a year ago.

The pulp, paper, and board industries operated at a much higher level during the first quarter of 1954 than over-all American industry. The Federal Reserve Board index of industrial production during the first quarter was about $7^1/_2$% below the same period of 1953 while total paper and board production declined only 1.2%. Paper production showed a gain of 3% over the first three months of last year, whereas paperboard production declined 4% in similar comparison.

There are a number of reasons accounting for the strong position of the pulp, paper, and paperboard industries as compared to the average of all United States industrial output. Among these is the placing on the market of new products and applications of paper and paperboard, which has been an important factor for many years in the continued steady growth in per capita consumption. The return to competitive conditions in business generally has resulted in a strong upturn in sales promotion and advertising, which means more printing papers, especially coated papers, for advertising pamphlets. Also, advertising in periodicals, as well as newspapers, has been at very high levels in recent months.

Another significant favorable factor is that there was no substantial accumulation of paper inventories in the hands of manufacturing mills, converters, printers, wholesale merchants, retailers, or other consumers, which had to be liquidated during the past several months. The net result was that for most grades and items actual demand in the first quarter of 1954 was translated almost directly in terms of production. Exports of pulp, paper, and paperboard showed large percentage gain this year over the first quarter of 1953.

Notwithstanding the fact that United States total industrial output in the aggregate was below the first part of 1953, the economy as a whole was running at a very high rate during the first four months of this year. Consumer income and expenditures were also very high which has had a strong stabilizing influence.

Many diverse trends in the levels of production and consumption by individual industries are observable from the first quarter statistics on American industry. Even within given industries there have been different trends in individual companies. For the most part, those particular companies showing pronounced strength in production have been the ones to take aggressive action in recent years toward modernization of plant equipment, development of new products and applications, coupled with modern market research and marketing and sales techniques. Consumer expenditures for the majority of nondurable goods have held strong and steady. On the other hand, there was some decline in purchases of consumer durables, especially for the first two months of the year, with some recovery noted in March and April.

One of the strongest favorable signs affecting the immediate outlook for the paper and paperboard industry, as well as most other industries, is the fact that the gradual but steady liquidation in the aggregate of manufacturers' and distributors' inventories has continued so that by April many companies had reduced inventories to a more normal relationship with production or sales. This inventory transition has taken place with only a moderate effect upon the economy and with a continued steadiness in prices. Furthermore, these adjustments have occurred during a period of declining government expenditures, particularly government spending for defense. Also, construction, being one of the important mainstays of the economy, has been holding up well. These various factors point to considerable underlying strength throughout industrial and distribution circles for the immediate period ahead.

Imports and Exports

United States imports of paper, board, and products during the first three months of 1954 were practically identical to the tonnages imported in the same period a year ago.

Paper imports as a group were up 0.6% over the 1953 period. Newsprint represents by far the largest volume of imports of any grade, amounting to 1,202,000 tons in the first quarter of this year, a gain of 0.8%. Noticeable gains were also recorded in greaseproof paper, up about 150 tons over a year ago, or 38%; while imports of thin paper were up about 30 tons, or 11%.

Imports of various grades of board during the first quarter totaled nearly 22,000 tons, a decline of 25.5% below the first quarter of 1953. All grade groups showed declines, except kraft container board, which recorded a gain of nearly 15%.

Imports of converted paperboard products totaled about 4500 tons, recording a loss of 19% under the first three months of 1953.

Large percentage gains were recorded in exports of most grades of paper, board, and products during the first quarter of 1954 as compared to the same period of 1953. In terms of group totals, paper exports totaled about 58,000 tons, or a gain of nearly 31% over a year ago; board exports, including paperboards, totaled 60,000 tons, a gain of 45%. Shipment abroad of converted paper and board products totaled 21,000 tons, being approximately equal to the volume of the first quarter of last year.

In terms of specific grades of paper or paperboard, the most notable increases percentagewise were in newsprint paper, kraft wrapping, and converting paper, shipping sack paper, coated printing papers, and container boards.

It is evident that domestic mills are placing greater emphasis on sales efforts in foreign countries and, because of improved currency situations in foreign lands, these efforts have proved very fruitful in the first three months of this year.

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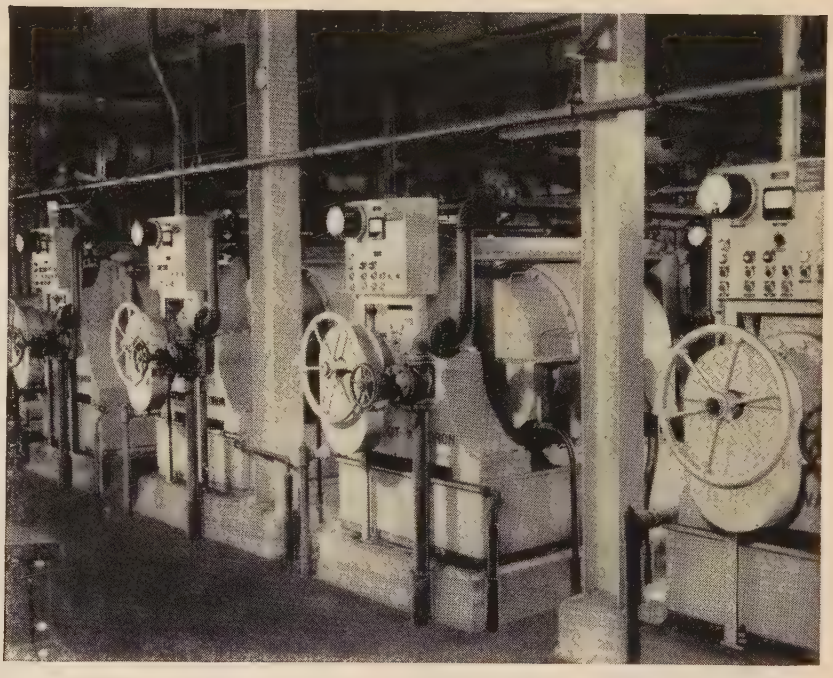
36-2 REFINERS



Four of the eight Sprout-Waldron 36-2 refiners at American Box Board Company, Filer City, Michigan. All eight units refine neutral semi-chemical chips for 9 point corrugating board in this most modern semi-chemical mill. Two were installed in 1948, one in 1949, four in 1952 and one in 1954. Repeat orders, such as this, are the best evidence of customers' satisfaction with Sprout-Waldron Refiners.

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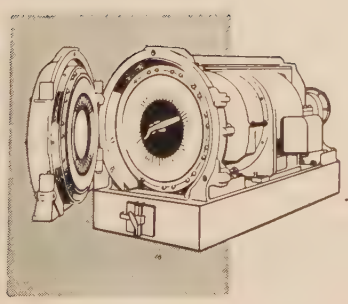

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PULP REFINERS

361

Pulpwood

In the area of pulpwood, more industry interest lies in future supplies of pulpwood timber than in any current procurement problems. Recognizing that wood will continue to be the fundamental source of fibrous raw material for the industry, practically all companies are continuing active in the acquisition of additional timberlands either under their own purchase or through contract arrangements so as to meet the needs of rapidly rising pulpwood requirements in the decades ahead. Latest data assembled by the American Paper and Pulp Association show that the industry now owns 25.8 million acres of timberlands, with an additional 2 million acres under lease. Furthermore, the industry has been a leader in applying extensive forestry practices in their own woodlands as well as in privately owned woodlands, in terms of sustained yield, fire and insect control, cutting and utilization practices. In this connection, it is especially noteworthy that the industry currently employs 1234 trained foresters and is supervising the planting of about 75 million seedling trees a year.

Four months' receipts of pulpwood, January through April, totaled 9,065,000; slightly more than 100,000 cords above the comparable period last year. Domestic receipts increased about 80,000 cords and imports approximately 22,000 cords. Regionally, the Northeast, Lake States, and Pacific Northwest showed increases while decreases were registered in the Appalachians and South, in the latter case rather substantial.

Consumption continued at high levels and by the end of April had reached 9,423,000 cords, 171,000 cords more than for the January–April period last year. Though the Northeastern, Appalachian, and Lake States regions showed small decreases in consumption a substantial increase occurred in the Pacific Northwest. Consumption in the South increased only slightly.

Inventories at the end of April were 5,280,000 cords, a decrease of 391,000 cords from March-end inventories and a decrease of 318,000 cords from inventories at the end of April, 1953. Decreases from a year ago ranging from 4 to 13% were reported in the Northeast, Lake States, and Pacific regions. Nominal increases were reported in the Appalachian and Southern areas.

Wood Pulp

Production of wood pulp for the first 4 months of this year was 5,887,000 tons, an increase of 91,000 tons over production for the comparable period last year. April production of 1,480,000 tons was only slightly above production in April, 1953.

Imports of wood pulp for 1954 through April were 648,000 tons, a decline of 55,000 tons from last year. Overseas imports were down 40% or 78,000 tons, while imports from Canada increased 23,000 tons, or 4%.

Exports of wood pulp for 1954 continued high totaling 85,000 tons by the end of April, double the quantity exported for the same 4-month period last year.

Inventories of wood pulp declined slightly in April, dropping 6000 tons under inventories at the end of March. Inventories at the end of April were 658,000 tons—161,000 tons at pulp mills and 497,000 tons at paper and board mills. The decline of 6000 tons was about evenly divided between pulp and paper mills.

U. S. Wood Pulp Imports, January–May, 1954 and 1953

	1954[a]	1953[a]	Per Cent change
Canada	661,090	648,126	+ 2
Sweden	84,060	147,618	−43
Finland	47,661	72,769	−35
Norway	6,243	21,383	−71
Germany	...	588	..
France	50	75	−33
Austria	...	5,998	..
Portugal	25	...	..
Total Europe	138,039	248,431	−44
Total world	799,129	896,557	− 9

[a] Short Tons.

Wastepaper

The month of May was better than the average for both mill purchases and consumption of wastepaper among the Eastern mills. Although receipts dropped 1/2% from April, consumption topped April by 1.4%. Compared with the month's average receipts and consumption for the previous eight years, May, 1954, was 1.6% better than the average May in mill purchases and 2.4% ahead of the average May for wastepaper consumption.

Special emphasis continued to be placed upon the quality of the paperstock by the consuming mills, and numerous dealers were pointing out to the packers the importance of careful sorting and packing to prevent rejections by consumers.

More wastepaper was consumed by the Eastern mills in June's second week than any previous week this year since in the last week of January. They purchased 95% of the paperstock consumed during the week. Compared with the like week of 1953, consumption was down 3.5% and purchases were off 3.9%.

Ninety-eight Eastern mills, manufacturers of paperboard, wallboard, roofing, and paper, consume old corrugated boxes. Some of these mills are very large, consuming large tonnages daily of old corrugated. The smaller mills, too, are included. Their total annual consumption of old corrugated can only be estimated, but it is a well-known fact that the paperboard mills are consuming a relatively higher proportion of old corrugated than in recent years and the building materials mills are consuming substantially more.

The Waste Paper Utilization Council has issued a brochure titled "Prohibited Materials and Outthrows in Paper Stock." This booklet lists the various materials found in wastepaper which are considered harmful and objectionable from the standpoint of reuse, some of the major sources or types of salvaged paper and board products where these may be found, and some simple tests that can be used to identify these troublesome materials. Copies of the booklet are available upon request from the Waste Paper Utilization Council, 122 E. 42nd St., New York 17, N. Y.

Corrugating Board

Production of corrugating board from various pulps is given below for 1952 and 1953.

Pulp finish	Production, tons 1952	1953
Semichemical	846,100	1,042,200
Kraft	213,100	216,900
Straw	275,700	275,700
Other	293,100	367,900

Boards under the first three categories must contain at least 70% pulp; the remainder may be wastepaper. "Other" is all production having more than 30% wastepaper in the furnish.

Conservation

The Commission on Intergovernmental Relations has announced the formation of a Study Committee to examine the field of Conservation and Natural Resources. This group will consider questions of Federal and State aspects of land and water management, utilization and conservation, and will also review Federal aid in the fields of State and private forestry cooperation and fish and wild life restoration and management. William S. Rosencrans of Los Angeles,

chairman of the California Board of Forestry and past-president of the American Forestry Association, has been appointed chairman of the committee. Other members of the committee include Bernard L. Orell, vice-president of the Weyerhaeuser Sales Co. and Charles H. Sage, vice-president of Kimberly-Clark Corp.

Community Relations

A study by the National Research Bureau, Inc., Chicago, Ill., reveals that at least 14 newspapers in the country are publishing house organs for local industries "to tell the plant community about its (the industry's) activities and its employees."

The NRB study says that the publication of house organs as newspaper ads results in lower cost; greater local readership; timeliness; and over-all more effective public and community relations.

Most of the companies using this method of C-R promotion use at least one page a month in their local newspaper, with the copy used variously in support of civic projects; as a picture page on company activity; or as a news page carrying plant and personnel news.

Water Resources Committee

President Eisenhower has created a new Cabinet Committee on Water Resources Policy and has called for modernization of the Federal program. Full-time members of the committee include Secretary of the Interior McKay, chairman, Secretary of Defense Wilson, and Secretary of Agriculture Benson. Secretaries of Commerce and of Health, Education, and Welfare and the Director of the Budget, as well as several others, will serve the committee in a limited capacity. The President directed the committee to cooperate in its study with the Hoover Commission.

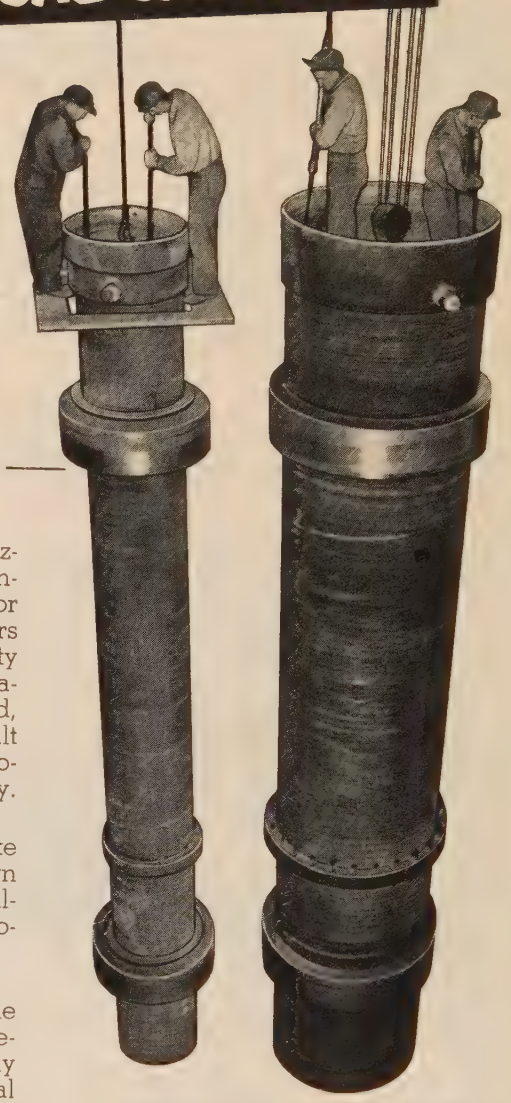
Reusable Sack Symbol

Members of the Paper Shipping Sack Manufacturers Association have adpted the A/N/K symbol to designate a multiwall sack which would be suitable for repulping and which would contain only all natural kraft. Copies of the descriptive leaflet have been sent to all members of the Paper Shipping Sack Manufacturers Association, wastepaper dealers, members of the Waste Paper Utilization Council, and other interested parties.

Pulp & Paper Facts

The American Forest Products Industries, Inc., has published a fact book on the nation's pulp, paper, and paperboad industry in cooperation with the American Paper and Pulp

GIANT MOLDS FOR CHIEF SANDUSKY . . . THE GIANT OF CENTRIFUGAL CASTING



When specifications call for cylindrical castings—call in Chief Sandusky.

Making the finest cylindrical castings is a science and an art. Chief Sandusky has mastered the various steps which constitute it. Year after year "The Chief" is responsible for centrifugal castings that meet the most exacting requirements.

Solving metallurgical "puzzles" for paper mill machinery users of such castings for roll shells, covers, and liners has always been a specialty of Sandusky Foundry & Machine Co. Proposing sound, practical answers for difficult problems is a regular procedure with Chief Sandusky.

First, there is immediate access to the company's own experts as well as to specialists in leading research laboratories.

Second, experience is one of the most valuable resources. And in the highly specialized field of centrifugal castings for paper mill machinery Chief Sandusky is indeed resourceful, having over forty years' experience.

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CENTRIFUGAL, CASTINGS FOR ROLL SHELLS, COVERS, and LINERS.

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Association. Factual data included in this brochure cover many phases of the industry with supporting tables on production, consumption, imports, uses, number of mills and workers, etc.

Alaska

Alaska's first pulp mill, Ketchikan Pulp Co., has begun operations and will produce over 100,000 tons of bleached pulp annually. The mill costs over seven times the purchase price of Alaska from Russia in 1867—$7,200,000.

Benelux

Belgium, the Netherlands, and Luxembourg have removed all quantitative restrictions on imports of paper and paper products from the United States.

Peru

Peruvian import duties have been substantially increased on many converted paper items, effective 90 days after official notification published in *El Peruano*, April 24, 1954. Approximately 55 items are covered including in part, waxed paper, boxes, bags, envelopes, blotting paper, and printed invoices. The declared purpose of the duty increase is to provide protection to local industry.

New Zealand

Construction is well under way on the Tasman Pulp and Paper Co's newsprint mill at Kawerau, N. Z. The mill is being

New Zealand's first newsprint mill. This view shows Mt. Edgecumbe looming in the background. Stores building is at the left end of mill and administration building is at center. Pulp drier room is immediately to right of administration building

built by Merritt-Chapman & Scott Overseas, Inc. in cooperation with the Raymond Concrete Pile Co., New York, and the Fletcher Construction Co., Auckland, N. Z.

Austria

New all-time records were set in the production of both pulp and paper in 1953, as the investment program of the industry neared completion. Installed annual capacity is now estimated at 350,000 metric tons of chemical pulp, 120,000 of mechanical pulp, and 350,000 of paper; the production rate during the latter part of the year approached these capacity rates. Exports of pulp and paper were at a postwar record high, with about 56% of the total output of paper going into the export market.

The investment program of the pulp and paper industry, begun in 1950, is now substantially complete. As a result, production capacity for chemical pulp is estimated at 350,000 metric tons, and for mechanical pulp at 120,000. Production of mechanical pulp during 1953, at 114,799 metric tons, approached the capacity rate. Output of chemical pulp, on the other hand, at 294,891 metric tons, was considerably below the new capacity rate, since several of the new mills did not go into operation until toward the end of 1953. Barring unforeseen unfavorable market developments, 1954 output of chemical pulp may be expected to show a considerable increase over 1953.

The economic position of the pulp and paper industry was affected unfavorably during the year by a pronounced increase in the price of pulpwood. As a result, an increase of approximately 18% in the domestic price of pulp has been made effective March 1, 1954. This increase, in turn, has caused the paper mills to announce domestic price increases ranging from 9% for some special papers to about 22% for newsprint.

Since the increase in consumption of wood pulp by Austrian paper mills did not match the large rise in production which took place during 1953, the surplus exported rose from 95,032 metric tons in 1952 to 129,734 in 1953. Italy was the most important country of destination of Austrian pulp exports, accounting for more than 50% of such exports.

Production of paper during 1953 totaled 296,411 metric tons, an increase of 44,706, or about 17%, compared to 1952. As in the case of wood pulp, this advance was brought about mainly by two factors: increased capacity as a result of the industry's investment program, and generally favorable market conditions. During the latter part of 1953 and the early months of 1954, Austrian paper mills were so well supplied with orders that they could accept new orders only by stipulating a two-to-three-month deferral of delivery. Total annual capacity of Austrian paper mills is now estimated at 350,000 metric tons, but since some of the new facilities went into production during the latter part of 1953, this capacity is not fully reflected in 1953 production figures. Production during the fourth quarter of the year, however, was at an annual rate of about 340,000 metric tons, and it is believed that this rate will be maintained or perhaps increased slightly during 1954, provided market conditions remain favorable.

A production increase of 44,706 metric tons, combined with a decrease of about 5000 tons in domestic consumption, resulted in a jump in export volume from 116,887 metric tons in 1952 to 165,816 in 1953. About 56% of total production in 1953 was exported. The German Federal Republic was the most important country of destination, but exports were sent to more than 60 other countries in all parts of the world.

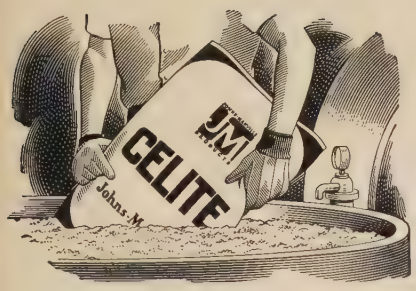
Brazil

Domestic production of paper in 1951 was approximately 287,000 tons and remained about the same in 1952. Though official statistics for 1953 are not yet available, trade sources are of the opinion that both production and consumption were higher than 1952, and that 1954 output will show an estimated increase of 50,000 tons as compared with 1953.

Colombia

A factory for the processing of wood pulp into fiberboard, cardboard, and paper is expected to be established in Barranquilla. The actual plant will be located on the Carrara River, 40 km. east of Puerto Berrio in the Department of Santander, with production beginning in about 14 months. Once the plant is functioning, research in the manufacture of newsprint from tropical woods will be undertaken. The name of the firm will be "Laminas de Fibra del Carrare, S. A." organized as a corporation with an authorized capital of 4,666,660 pesos ($1,866,000). To date, 2,102,000 pesos ($840,800) in bonds have been subscribed to with two million purchased by the government's Instituto de Colonizacion e

How Celite speeds board output up to 10%



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You will find that Celite is a highly porous material, with exceptional free-draining characteristics. Since it does not cake up or shrink, it materially improves drainage and drying, makes increased machine speeds possible. And because of its good suspension properties, Celite helps keep fibers evenly dispersed in water, resulting in greater uniformity of finished board.

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To prove these advantages of Celite, a Johns-Manville Celite Engineer will gladly assist you in making trial runs in your mill. There is no charge for his services. Simply write Johns-Manville, Box 60, New York 16, N. Y.

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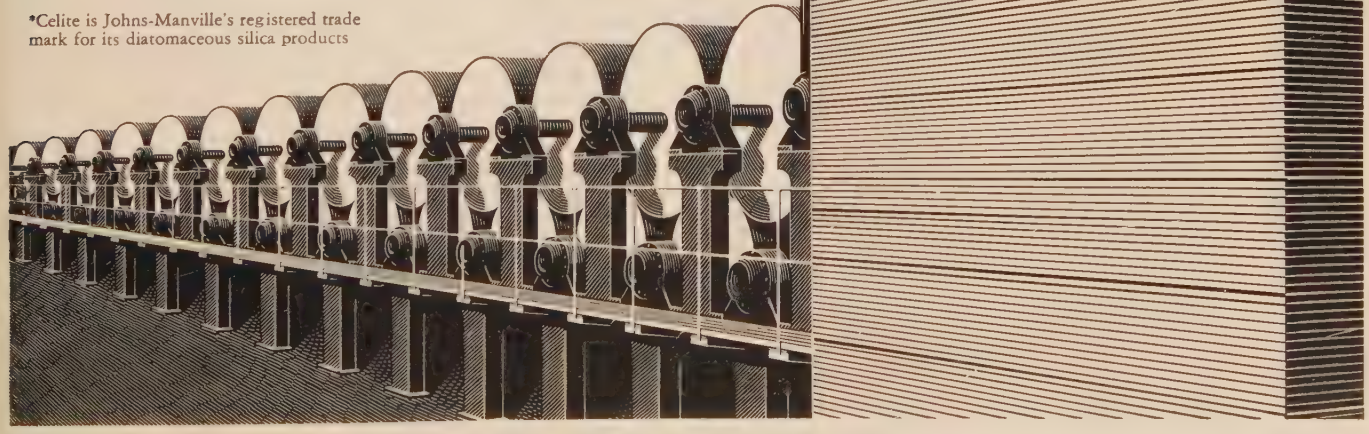


JOHNS-MANVILLE JM PRODUCTS **Johns-Manville CELITE** PRODUCTS FOR THE PAPER INDUSTRY

Immigracion and the other small amount by Barranquilla business men. The national government is interested in encouraging the development of the vast lumber resources of the country and if this project is successful, it may well have the desired effect. The small participation of private capital at this early date, however, is an indication that most local businessmen are very cautious concerning this new factory as considerable venture capital has already been lost in previous wood cutting or wood processing factories in Barranquilla.

Finland

Production of chemical pulp during February and March continued at a high level. During February, which is a short month, production was 120,000 metric tons and during March, production was 135,000 tons, the highest monthly total in more than two years. Because of this high operating rate, inventories continued to rise during February and March despite maintenance of shipments at a high level considering that the majority of Finnish ports were closed. Finnish inventories of chemical pulp at the end of the first quarter totaled 82,000 tons, as compared to 161,000 tons a year ago.

Finnish pulp producers have begun to work on establishing prices for the third quarter. No change in prices to the United States is expected but it is possible that some slight increase may apply to continental markets.

Paper production has also gone up. Production of all grades of paper during March was 73,000 tons, an increase of nearly 13,000 tons over the monthly average during the last 12 months. During the early part of April a new paper machine was placed in operation at Tervakoski. This machine, which is designed for making condenser paper and other lightweight grades, has a maximum wire trim of 118 in. and is designed to run at a speed of from 50 to 65 f.p.m.

Germany

During 1953 the paper and pulp industry entirely recovered from its setback in 1952 and resumed its postwar expansion under normal and sound marketing conditions. Production and consumption considerably increased reaching new postwar peaks. Prices, while still above the world market level, dropped during the first half and remained stable during the second half of the year.

Due to the rise in paper and paperboard consumption as well as to cheaper world market prices, the quantity of pulp and paper imports far exceeded that of the previous year. Exports also increased in quantity over 1952 but to a lesser degree than imports. Trade with the United States remained negligible.

Production and sales are expected to remain high and supply of all raw materials should be adequate. Some price rise appears assured in response to rising Scandinavian prices and continued heavy demand.

The high production figures for 1953 were due partly to a general upswing in the world market, especially the Scandinavian markets on which Germany depends for much of its raw material imports, and partly to the favorable development of the German economy as a whole. A business condition characterized by strong demand, increased production, and high employment, at stable prices stimulated domestic demand for all types of paper and paperboard.

Raw materials remained in good supply during 1953, although as usual the West German paper plants had to supplement domestic supply with sizable imports. Fiber wood imports amounted to 25.8% of domestic production while imports of all types of pulp totaled 31% of home output.

During 1953 the industry launched an intensive advertising campaign under the motto *Papier schützt—Papier nützt* (paper protects, paper is useful) in order to increase the use of modernized packaging methods and wrapping paper. Further efforts in sales promotion were made through participation in trade fairs, presentation of educational and advertising films, and by editorials and studies in newspapers and periodicals.

As the German paper and pulp industry does not have the production capacity to meet even domestic demand, exports are generally limited to certain types of high grade paper and paperboard and to small quantities of sulphite and other miscellaneous pulps. No mechanical pulp or newsprint was exported in 1953.

The Netherlands was again the leading purchaser of German paper and paperboard receiving 8127 metric tons. Exports to Egypt showed a surprising increase from 128 metric tons in 1952 to 3636 metric tons. Other countries to which sales notably increased in 1953 were Belgium, Switzerland, and Hong Kong. Exports to the United States remained extremely low, amounting to 7800 metric tons valued at DM 2.9 million ($688,600), the bulk of which consisted of surfaced and impregnated paper.

The outlook for the paper and pulp industry in 1954 remained generally favorable, at least for the first half of the year. The post-Christmas seasonal slump was smaller than usual and the over-all economic condition of high production and demand at stable prices continued into the new year. As a result of the increasing economic and cultural activity of the country, the rising trend in paper consumption is expected to continue. Paper and pulp production should remain at its present high level while newsprint output is expected to increase to about 220,000 metric tons as compared to 202,600 metric tons in 1953. Supplies of all important raw materials should be plentiful as no further import restrictions are envisaged in the near future.

Under the stimulus of rising prices in the Scandinavian market and continued high domestic demand, German paper and paperboard prices began to rise in December. Prompted by these factors as well as rising fiber wood prices, the pulp industry planned to increase its prices by 5% beginning in February, 1954.

With demand still strong and Scandinavian prices rising, a consequent rise in German paper and pulp prices is not unnatural. However, as the price indices for paper, pulp, and paperboard in 1953 were all over 300 (1938 = 100) compared to an index price of 217 for German industry as a whole, a rise in prices carries with it certain risks, which cause producers considerable concern.

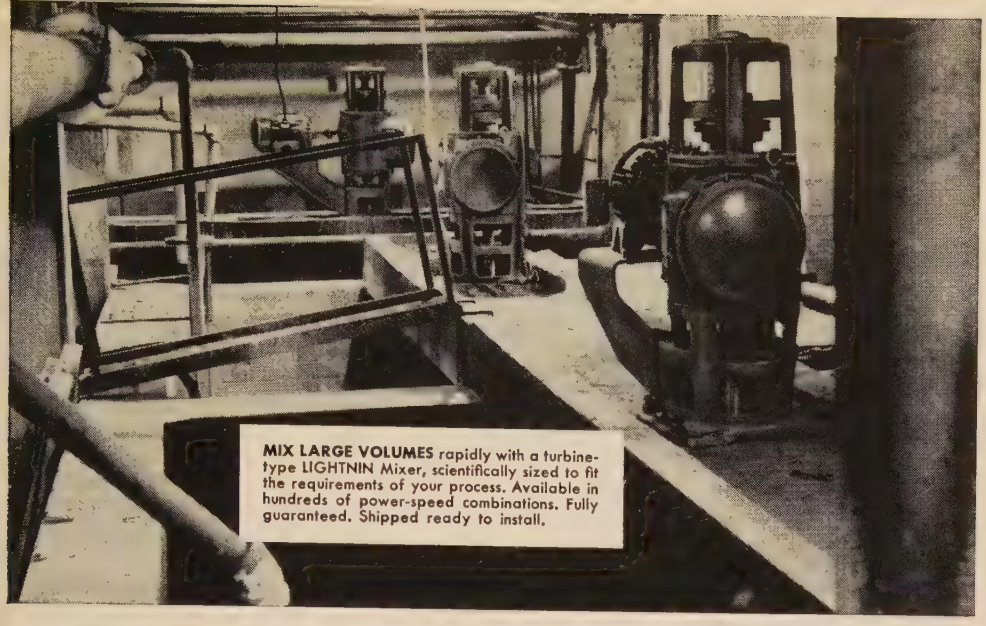
Paper and paperboard where used as packing materials are already meeting increased competition from synthetic materials such as foils, which possess high technical perfection (imperviousness to water, gases, odors).

An increased disproportion between the price index of paper products and that of other domestic goods may also frustrate the industry's advertising campaign aimed at increasing paper consumption especially in the paper packaging field. At a time when the German retailers and shoppers are being introduced to modern packaging methods, it is extremely important for the long range success of the industry that this innovation be presented as attractively as possible.

Liberia

The Liberian government has granted the Society for the Utilization of Vegetal Raw Materials, a German organization, a general 250,000-acre concession for a term of 80 years. The concession is based on an option granted to the Society in October, 1952.

Interest has been expressed in the development and exploitation of forest and mineral resources, the establishment of forest industries, and the development of oil, palm, cocoa, and coffee plantations. The development schemes include the construction of a chipboard factory and a cellulose pulp plant. The Society hopes that this will make it possible to utilize most of the available timber within limits established by the Forest Conservation Act. Many individuals have been too optimistic concerning the development of Liberia's timber



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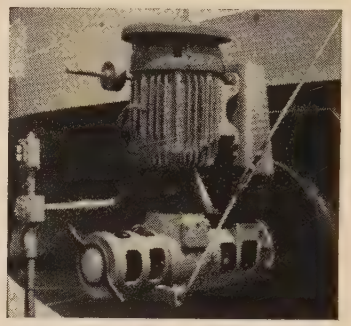

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resources. Inaccessibility has always been a great obstruction.

Portugal

Under the 6-year plan for economic development, the Portuguese government plans to spend about 35,000 escudos ($1,225,000) to further develop its pulp and paper industry this year.

Sweden

The short-term outlook for Sweden's pulp industry continues to be very favorable but there are storm warnings of potential trouble ahead if North American pulp is sold in volume in Europe below Swedish prices. Sweden's output of pulp has been sold out through June and the output of dissolving pulp and newsprint almost through December, 1954.

In 1953 Sweden exported to the United States 286,285 metric tons of cellulose pulp worth $32,750,000 according to preliminary official statistics. Local trade circles hope (and probably expect) to sell 225–250,000 tons to that market in 1954 even though Swedish prices to Europe are somewhat higher than the American level at the present time. The second quarter prices for 1954 are 3 to 4% or about £1 per long ton higher than in the first quarter for sulphate and £2 or $5.00 higher for sulphite, with the larger mills raising their quotations to those of other mills selling successfully to the United States. European demand remains brisk and prices have been edging upward steadily since last September. The European market for dissolving pulp is now very good but the price of £63½ or 900 crowns ($173) per ton is considered much too low but is not expected to change before 1954. It is felt America's foreign demand has been replaced by greater domestic production within the United States. The USSR is said to have sought in vain to purchase 8000 metric tons of viscose (89 to 90% alpha) in Sweden, for sterling, to supplement the 32,000 allegedly bought in Finland this year.

Despite the continuation of favorable market trends in Sweden the Summer months may see a serious change. It is claimed that France has signed a 5-year reservation contract* to buy bleached sulphite: this year at 790 crowns ($152) per metric ton c.i.f. as against 825 ($160) quoted by a leading Swedish mill today. British importers are delaying new purchases of bleached cellulose from Sweden and Finland because, it is claimed, United States and Canadian mills are offering immediate delivery at £1 per ton less.

Pulp sales were very lively in March after second quarter prices were firmly set at about £1 to £1:10 above the levels of the previous quarter. (Only minor adjustments, no real change, were made in prices quoted to the United States.) This means the Swedish mills are getting from 50 (for sulphite) to 100 (for kraft) crowns ($10 to $20) less per ton of pulp sold to the United States than elsewhere.) Actual shipments were at the annual nadir of 83,000 metric tons and exports to the United States reached a 2-year low mark of 2650 tons due to severe ice conditions but possibly also a harbinger of future marketing difficulties to come.

Local trade circles are somewhat annoyed at the recent contracts for almost 50,000 tons of paper pulp placed by the Argentine government in the United States for payment in dollars, after Sweden lost the bids by insisting on payment in dollars or sterling instead of in Swedish kronor. Apparently the American price was below the Swedish offer and the terms of payment were not the only Argentine consideration. Certain Swedish dealers blame the outcome on their inflexible salesmanship and expect to feel elsewhere the pressure of American bargaining skill.

Incomplete reports on timber floated this season indicate a 14% increase over the 1953 crop. The association in charge of floating on the four rivers of the Umeå district (north of Sundsvall) have been requested to deliver 14.6 million logs this year and tree-felling is now completed. Imports of pulpwood from Finland are also expected to be larger than last Summer with the result that everything seems to point toward increased pulp output in 1954.

* With Canada

Union of South Africa

The large rayon pulp enterprise at Umkomaas is expected to be in production by mid 1955, and the paper mill Mandeni will commence operations during the early part of 1954.

A new paper milling venture is negotiating for a factory site in Durban and several small factories have in mind the expansion of their activities.

United Kingdom

1953 was a year of recovery in the United Kingdom paper industry following the severe recession which hit the industry during 1952. In the early months of the year trade was slack, but from April onward business showed an improvement until by the closing months of 1953, paper mills in the United Kingdom were booked with orders for some considerable time ahead.

The recovery was due to a number of factors, perhaps the most important being the freeing of restrictions by the Ministry of Food on the control of certain foodstuffs, chocolate, and candy which led eventually to a greater demand for wrapping and packaging papers. It is also expected that there will be an added demand for waxed cartons and waxed tubs, as margarine and cooking fats have been derationed by the Ministry of Food after fourteen years. Manufacturers of these products are believed to have made elaborate plans for marketing their goods in more attractive packages and wrappings.

The United Kingdom paper industry has always been very interested in its export trade and is making every effort to maintain and increase its business overseas. However, during the last few years, Australia (the United Kingdom's biggest export market), India, New Zealand, and South Africa, have all increased their own papermaking potential and in some cases they are more or less self-sufficient in the production of certain grades of paper and board. It is possible that United Kingdom exports of paper and board to these countries will decline when the recently constructed local paper mills come into production.

Although the events of 1952 and 1953 have proved that the situation in the paper industry of the United Kingdom can change almost overnight, it is the opinion of reliable sources in the paper industry that the exceptionally good prospects which the United Kingdom paper industry is enjoying at the present time should, unless something unforeseeable occurs, continue throughout 1954.

Yugoslavia

According to *Vjesnik* of May 1, in about ten months Yugoslavia will be completely self-sufficient in respect to its newsprint requirements. According to this paper, a factory is now being built at Videm Krsko which will produce "350 meters of newsprint ribbon every minute which will be 4.2 meters wide." It is pointed out that since this is too wide for ordinary use special machines will be installed to cut it into suitable size. The hills around Videm Krsko are said to abound in conifers, especially fir trees, which will provide the necessary raw materials. Annual production is estimated at 20,000 tons of newsprint and the cost of this plant is reported to be around 3,170,000,000 dinars ($1,060,000).

Charcoal from Scrub Hardwoods

The task of removing scrub hardwood from pine stands in the South is no longer all work and no pay.

Hardwood charcoal production from nonmerchantable trees is actually financing a stand improvement program on the Talbrion Tree Farm near Geneva, Ga. Blackjack, oak, hickory, and other hardwood is removed from the land, cut into 4-ft. lengths, and trucked to nearby kilns made of heavy

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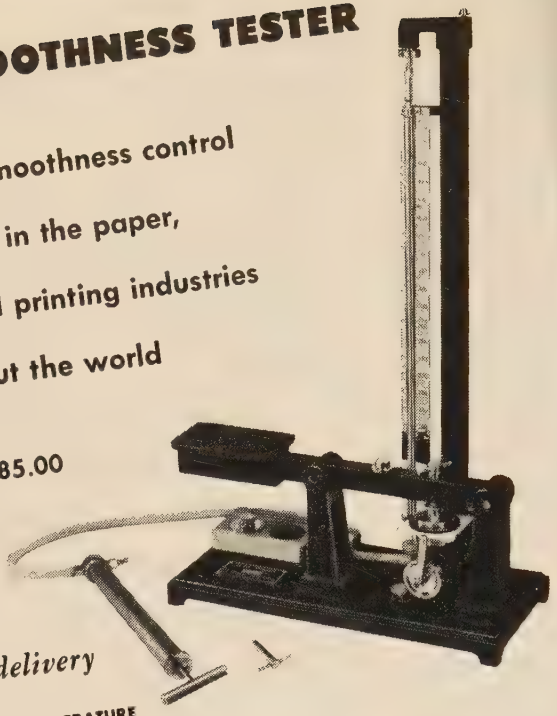

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steel. After the 4-day "cooking" and cooling period, the charcoal is bagged and put on the market. Most of it is used by barbecue entrepreneurs.

Coating Machines

The function of the coating machine is to apply the liquid color to the base stock, smooth it to an even film of the desired thickness, and pass the wet web to a separate or integral piece of mechanism which will dry it for further processing. There are two types of conventional coaters in general use in the printing paper field—the brush coater and the air knife coater. The brush coater is considered not as efficient for standard grades as the air knife, but it still gives excellent quality, and is used for small runs or specialty work. The air knife coater is modern, achieves good quality, and is capable of high speeds. It is therefore a mass production machine.

In a mill producing a variety of grades, there will be several different machines running different kinds of colors at one time. To keep these supplied with coating color requires a considerable amount of equipment and organization, all under the general heading of color preparation. The first step is to dissolve the various adhesives or binders in water. In the case of casein, heat, plus ammonia or other alkali is used to hasten the dissolving process. Successive batches of these are made up and run into storage tanks with a system of constant checks to make sure of uniformity. In the meantime, the various pigments in use are made up into a thick slurry and likewise stored in vats.

The contents of the storage vats are drawn on as desired in the color mixing room, usually on the floor below. Here, the adhesive and color slurry are piped into a mixing vat fitted with agitators which mix the contents thoroughly. Dyes, plasticizers, waxes, and any other ingredients called for are added. After mixing, the color passes through a fine screen and is piped directly to a color storage vat at the coating machine.

The Brush Coater

The brush coater is now almost 100 years old, having been having been developed in the 1860's. The first machines had rotary brushes to simulate the former hand-brushing technique. This type was superseded in the 1870's by the oscillating brush type, and was very similar to the machines used today. Essentially, a brush coater consists of a pan to hold the coating color, into which is revolved either a roll or round brush. This picks up the color and deposits it on the web of paper being unrolled into the machine. The wet web is supported on a smooth table or a moving belt and passes under a number of brushes which move from side to side. The first brushes are relatively stiff bristles, each succeeding set becoming softer and finer.

The brushes smooth out the coating so that an even film is applied across the web. They are adjustable to some extent, but it requires much skill to apply the correct thickness and keep it uniform across the width of the coater. When it is considered that a half thousandth difference between one edge and the other would mean a half-inch difference in 1000 sheets of paper, the coater's skill is amazing.

The Festoon Drier

As the wet paper leaves the coater, the web is picked up by a series of traveling bars which form it into a series of long loops, called festoons. These are advanced over a system of heating coils, and fans direct warm air at them. At the end of the room, they go round a semicircle, and return to the coater where a rewind device reels up the roll. It is now ready for its second pass through the coater which coats the reverse side.

Double Brushing

Because brush coaters are slow and their man-hour cost

high, this technique is usually too costly. It can, however, result in the very highest quality. Double brushing means the paper gets two coatings on each side. The two coats can be of the same formula or may differ. The precoat can be of a formula designed to fill in the base stock irregularities and enhance its color. The final coating may be of a more expensive and higher quality coating to achieve the maximum appearance and printing quality. This process is very rarely used now.

The Air Knife Coater

The air knife coater derives its name from the fact that it employs a jet of air to smooth the wet coating. It is a fast, mass production machine, but capable of producing good quality coated papers. Because of its high speed, festoon drying is impractical so it is usually combined with some type of drying tunnel.

The actual operating parts are rather simple even if operating it is not. As the roll unwinds, a pick-up roll or brush deposits an excess of coating color on the web. This next passes part way round a precision ground roll and in close contact with it. A thin jet of air under constant pressure is directed at the coating at a predetermined angle. The force of the air cuts and rolls back the excess color as if it were a knife. At the same time, it smooths the coating into a remarkably even film across the width of the roll.

The Tunnel Drier

This is a long chamber in one or several sections which dries the wet coating by heat and air circulation. The tunnel may be arranged vertically or horizontally, depending on available floor space and the kinds of paper made. A system of rolls and endless belts supports the paper as it travels through the tunnel, and hot air up to 350°F. is directed at the fast-moving web. At the Georgetown Mill of Alliance Paper Mills, a web 82 in. wide traveling at as much as 700 f.p.m. is dried continuously with this type of drying tunnel.

The Coating Load

The amount of coating color applied to each side of the paper is known as the coating load and is usually expressed as the number of pounds added to 1000 sheets 25 by 38. In Canada the standard load is 28 lb. per side, thus a base stock of 104M becomes 160M when coated two sides. This may be, to a degree, a compromise because for any one type of coating formula to be applied to a standard base stock and for each weight and for each end use there is an optimum color load. Such variations are impractical, thus over a long period this standard has been developed as best for average conditions.

The main functions of the coating color are:

(a) To fill in the hills and dales of the base stock, thereby producing a uniform surface.
(b) To improve ink receptivity.
(c) To screen the color of the base stock.
(d) To increase opacity.
(e) To achieve a smooth high finish.

Theoretically, the more color, the better these five characteristics, but we soon run into other difficulties. In any given weight of paper, as the coating load goes up, the fiber content must come down, and the strength of the sheet is thereby reduced. Furthermore, since the coating is not particularly flexible, an overloaded sheet may tend to crack at the folds, unless special formulation is used. Conversely, if the sheet is under-loaded, then opacity, color, and printing qualities may suffer.

The problem is not as acute in the heavier weights but in the lighter weights, the proportion of fiber to coating can become dangerously low. It is usual then to reduce the coating load to the minimum level, consistent with strength and quality. In some cases, the coating formula has to be ad-

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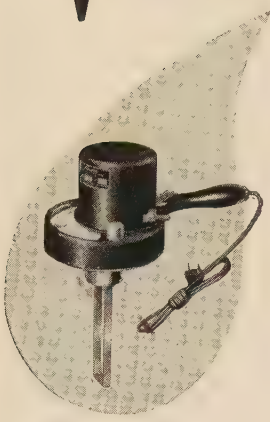

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justed and this, plus the mechanical difficulties of running thin base stocks and the lower tonnage produced per hour, leads to extra charges for the extra lightweight sheets.

Batch Process

Coated paper manufacture was originally a batch process. The coating color was made up in batches, each of which might exhibit slight differences from the others. Base stocks might vary and the machines had to be stopped and started when changing rolls. This all led to minor variations in the way the coating took on the base stock. The continuous operation of the air knife coater has been a factor in minimizing quality variation from roll to roll. Absolute uniformity is an ideal which cannot be accomplished but modern equipment together with improved technical control and better skill have resulted in much better control of quality. The success with which problems are solved from day to day is remarkable. This success is the result of teamwork applied to modern equipment, which is the goal of all modern manufacturing.

—from *Coated Paper Bulletin*, Alliance Paper Mills, Toronto, Ont.

Paper and Communications

Paper's growth has paralleled the progress of communications and pyramided the demand for specially developed papers. The rapid and essential growth of all forms of communication linking people today has long since reached globe-girdling scope . . . a growth matched and maintained by the pulp and paper industry.

As far back as the mid-nineteenth century, such innovations as these inventions called for quantities of paper to launch their success: Samuel B. Morse's telegraph invented in 1832; Charles Thurber's typewriter in 1843; Richard M. Hoe's rotary printing press in 1846; William A. Bullock's web printing press in 1865; Alexander Graham Bell's telephone prior to 1876; and the invention of Ottmar Mergenthaler's Linotype in 1884.

Today the communication field is gigantic in scope and encompasses such media as radio, television, publications in incredible volume . . . all large and constant users of paper. Similarly, in the ever-widening field of transportation, by truck, train, freighter, ship, passenger and cargo plane, paper is the lifeblood of operation. These demands for paper must be met by its producers and long range forest reserves must take into consideration this heavy demand on its resources.

—from *The Fraser Voyageur*, Fraser Co., Edmunston, N. B.

Paperboard Specifications

The physical properties of a sheet of paperboard are determined by many things; the type of raw stock used in the furnish, the type of treatment done to the fiber by refining equipment, the additives used to develop specific properties, the speed of the machine, moisture content of the sheet, design of the press sections and other mechanical devices. These all have a bearing on the appearance and strength of the finished board.

Following are a few of the terms which may appear in discussing paperboard specifications for functional packaging and are important to the "in-process control" of the paperboard manufacture.

Top Liner: An outer layer, generally the printed surface and side of the sheet exposed to view in the finished package. Composed primarily of pulps and high grade waste whites in white lined boards.

Under Liner: The ply directly beneath the top liner. In the case of a white lined board the brightness will be between that of the top liner and filler so as to improve the coverage of the top liner.

Filler: The greatest part of the sheet in per cent of weight. Depending upon the basis weight it will range from 35 to 65% of the total.

Back Liner: The outer layer and opposite to the top liner. Generally the inner side of a finished carton.

Formation: Refers to the uniformity of coverage of the top liner. A liner "bunchy" in appearance and not uniformly opaque is said to be "wild." Qualitative measurements are usually applied to this quality factor for top liner. (Papermakers will refer to formation on filler, under, and back liner as well.)

Bender: Depending upon the end use, the paperboard may be classified as a nonbender, 90° bender, or 180° bender. Generally speaking, the board for folding cartons must withstand a fold of 180° without rupture of the exterior surface unless the subsequent operations allow for a relaxed bender specification.

Mullen: The measurement of the bursting or rupture resistance of the paperboard and generally expressed as "points." By means of applying a uniform rate of pressure to a specific area the resistance to burst is measured.

Grain: Cylinder machines produce a sheet with a distinct grain or "line-up" of fibers. Line of sight parallel to the apparent "line-up" is referred to as with the grain. Line of sight perpendicular to the apparent "line-up" is cross-grain. In mechanical resistance tests the relationship of force to grain should always be expressed. (Relationship of carton dimensions with respect to grain is important to cartons functioning.)

Tear: The resistance offered to a tearing force exerted on the paperboard. This resistance is generally greater across the grain, on paperboard made on cylinder machines, than the corresponding test made with the grain. All specifications should state direction along with the numerical tear factor.

Stiffness: A measure of the rigidity of the paperboard; the resistance presented to an applied force causing the sample tested to flex. This mechanical test is taken with regard to both grain directions.

Caliper: The sheet thickness measured in thousandths of inches. Generally referred to as "points."

Basis (Regular Number): The number of sheets 25 by 40 in. to be found in a bundle weighing 50 lb.

Count: The number of sheets of paperboard of a dimension other than 25 by 40 in. to be found in a 50-lb. bundle.

Printability: The response of the paperboard to the printing process with regard to ink coverage, resulting gloss, drying rate, and other factors necessary to good reproduction.

Gage List: A standardization of weight and caliper relationships for various types of paperboard developed through an analysis of general practices in the paperboard industry. Variations may be made from these standards after an evaluation of a particular carton in question with regard to the specifications necessary for its successful manufacture and operation.

Finish: Degree of smoothness and density resulting from calendering and machine operation. Generally evaluated qualitatively.

Tensile Strength: The force necessary to pull apart a strip of paperboard of known dimension.

Sizing: Procedure used to impart resistance to penetration from such substances as water, mild acids, oils, etc. Depending upon the end use of the carton, the time necessary for a drop of the testing substance selected to be absorbed by the paperboard will be taken. The resulting resistance to penetration is important to printability, sealing properties, and wax receptivity for frozen food cartons.

Brightness: The reflectance of the paperboard surface compared to the reflection obtained from magnesium oxide as the standard or 100% reflectance. Specifications should be given with a standard and a plus and minus tolerance. (Many shades of color may give the same brightness, so in specifications a standard color shade for board should be given with tolerances exclusive of the brightness specification.)

Bond: The cohesive force existing between plys of the

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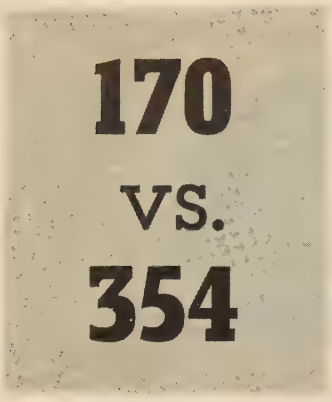

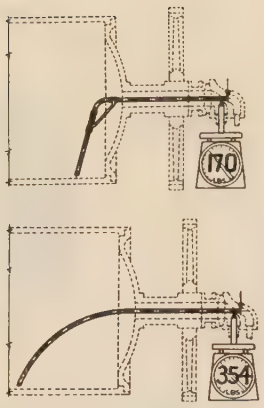

Here is a syphon that features a brace, a spring and low cantilever leverage on the steam joint.

The brace and spring make for easy insertion through the "joint" and proper clearance between pipe and dryer watt.

The leverage on the "joint" is only 170 lbs. in contrast with 354 lbs. usually exerted by the conventional straight pipe. Thus excessive wear on the "joint" is avoided.

Scores of mills use the Auto-Flex and so should you. Get a few on trial and they'll do their own selling.

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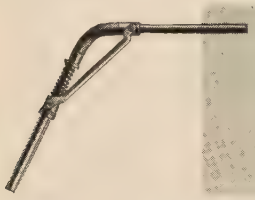
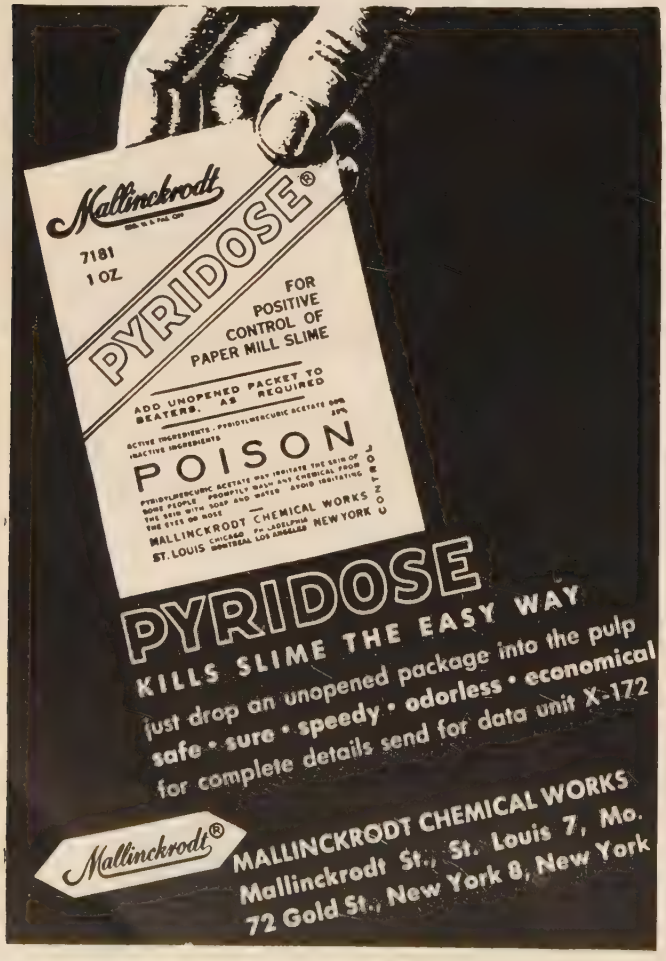


MIDWEST AUTO-FLEX SYPHONS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paperboard. Top liner must not separate from itself or the underliner during the printing operation when the sheet is subjected to the tack or pull during impression. Back liner bond is important to the sealing and filling operation. Poor bond in the filler can result in sheet wrinkles and cartons low in strength.

Pick: The test utilized to test the bond of the top liner as well as the effectiveness of the surface treatment applied at the calender stack. The picks are tack rated waxes which when heated are placed on the surface of the sheet and are allowed to "set" before being pulled from the sheet. The number of the pick which causes rupture of the surface is determined as not satisfactory.

Fade: Paperboard will fade when exposed to light, but various types will have varying rates of change. In considering packaging requirements, such as eye appeal, the basic selection of the type of board will determine the amount of fading on the unprinted areas upon exposure. Clay coated board, super white patent coated, and white patent coated will fade to a lesser degree than bleached Manila and single Manila.

Furnish: The formulation used for the manufacture of paper or paperboard. It will include the materials used in each system of stock with regard to type and percentage. The amounts of chemicals, size, dyes, fiber, etc., are all components of furnish.

Many factors other than those given above are involved in a complete set of specifications for a given grade of board and a folding carton utilizing the grade. Those given are of primary importance to the direct control of board production at the time of manufacturing.

With stock being prepared in the beater room 5 to 6 hours ahead of the board machine, adherence of the paperboard to specifications is the result of careful planning.

In setting specifications it must be remembered that every process has variations which are inherent in the raw materials and the manufacturing process itself. The efforts of the production division are directed toward minimizing these variations and to limit the normal variation of the end product.

Specific variables must be recognized and upper and lower tolerances established. Arbitrary specifications are dangerous from the standpoint of waste and potential complaints. Proper and adequate methods are applicable to establish normal variation in an operation and to establish the possible from the improbable.

—By William E. Watson, Technical Supervisor, Board Division, in *Box Talk*, New Haven Board and Carton Co., New Haven, Conn.

Paper Converting in the Orient

When we think of newsprint most of us visualize paper produced in large rolls for the printing of newspapers. Practically all newsprint manufactured leaves the mills in roll form and is printed into newspapers on presses that are identical the world over.

There are, however, forms and uses of newsprint other than the huge quantities of the familiar rolls which are printed as newspapers on the roaring presses.

A variation required by some printers and publishers is that of newsprint cut into sheets instead of rolls. At Powell River, as at other newsprint mills, fast cutting machines convert rolls into sheets. A number of rolls are placed on the cutting machine at one time and the sheets from all the rolls converge together to be cut quickly and accurately into newsprint sheets. In Hong Kong, however, they perform the same operation by hand!

There is a factory which takes newsprint in rolls and cuts it into sheets for sale, not only in Hong Kong, but also for shipment throughout the Far East. A man will place a newsprint roll on a stand and will turn a spindle by hand. The paper is wound on this spindle until a number of layers are built up.

Then the workman cuts across the paper with a knife and the result is sheet newsprint. Surprising accuracy of size and trimming is obtained. This is an interesting example of how, in some parts of the world, hand labor is maintaining its position and is performing efficiently and cheaply against the machine.

Another interesting practice in Hong Kong is that of coloring or staining newsprint. Colored newsprint has long been made by paper mills. The dyes to make the required shades are placed with pulp in slush form prior to the pulp being fed into papermaking machines. Another method employed is spraying the dye on to the paper while it is running off the papermaking machines. Both operations are considered to be of low cost. In Hong Kong, again, newsprint is colored or stained by hand.

First, from a pile of standard newsprint sheets a man pulls each individual sheet of paper through a bath of size. The sheets are hung on racks to dry and are again placed in a pile. Other men take these sheets and, one by one, place them on a table and paint or stain them. They use a wide brush, something like a calcimine or whitewash brush. The workman dips his brush into the dye and quickly applies it to the paper both to and fro and back and forth. A great deal of skill is shown by the man who works balanced on his toes like a boxer. Remarkable timing and coordination are acquired and their speed, with no waste motion, is amazing. Incidentally, the results are splendid, with the paper being colored evenly and uniformly. The sheets are then placed on racks to dry. The Chinese use this stained paper for many purposes. The principal ones are firecracker wrapping, joss burning, and for decorations. From Hong Kong they export the paper to Chinese all the world over. In a staining factory, long rows of workers are to be seen coloring Powell River newsprint without the aid of machinery.

An unusual use for newsprint, that is little known, is its burning in honor and worship of ancestors. The Chinese twist newsprint paper into cones and light them. Messages and worship are carried into the above with the smoke from the burning paper.

—by R. W. Foote, in *The Powell River Digester*, May-June, 1954.

Paper and Printing in New England

The following items relating to the status of the pulp and paper and the printing industries in New England were extracted from a report made by Arthur D. Little, Inc., Cambridge, Mass., to the Federal Reserve Bank of Boston. Although some of the statistics shown are a few years old the general study is interesting especially in its consideration of future possibilities:

Pulp and Paper in New England

During the early years of the twentieth century, New England maintained a dominant position in the pulp and paper industry. Since 1930, however, New England's economic position in this industry has slowly declined until it now constitutes about 15% of the entire United States paper industry. Other regions, especially the Far West, have more plentiful supplies of pulpwood of excellent quality. However, it should be noted that recent development of a process for utilizing hardwood will substantially increase New England's raw material supply. Pulp and paper mills in the West and South are run on a much larger scale and have more up-to-date equipment, such as high-speed machinery, resulting in more efficient, low-cost production. In some areas, also, the availability of cheap power is a decided advantage. An expansion of pulp manufacture in New England is limited as well by a lack of available sites on rivers in proximity to wood supplies. New England enjoys a definite advantage in paper manufacture, however, in being close to markets. The region's consumption of paper products is very substantial, and nearby New York and Mid-Atlantic markets are within easy shipping distance.

Chemical Pulping Processes

Chemipulp's high degree of chemical, mechanical and physical control over materials and operations results in maximum plant output, high pulp quality, and low operating costs.

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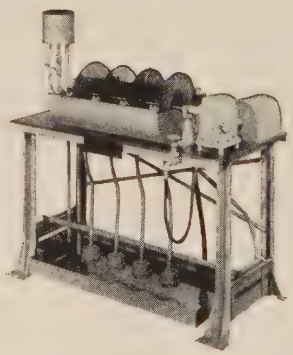

Control beating and refining processes on groundwood or chemical pulps. Excellent for coarse and fine pulps. Screens from 8 to 250 mesh available. Eight complete tests in one hour. Results reproducible within 1%. No recirculation or eddy currents. Open construction offers visual proof of progress of classification. Easily cleaned. Minimum maintenance.

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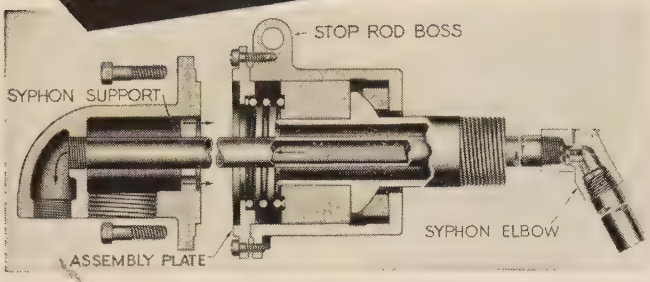

Here's a combination of new ideas that is getting a big welcome from the paper industry. It consists of the self-supporting Type S Johnson Joint — now with streamlined design for lighter weight, less cost and longer life of the wearing parts — with the addition of assembly plate and syphon elbow. Plate holds internal parts in position when head is removed to get at the syphon pipe. And syphon elbow permits use of straight pipe for syphon connections. Elbow seals tightly when in position, allows pipe to be inserted or withdrawn right through the joint body.

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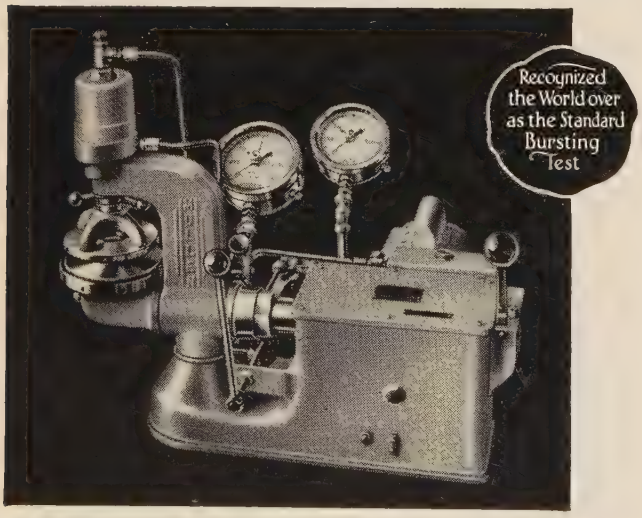

Especially designed for testing corrugated container board. Larger clamping area and reproducible clamping at any desired pressure eliminates crushing and slippage of the sample.

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There are still many opportunities for further industrial development within the pulp and paper industry. One of the most favorable opportunities lies in increasing production of high-grade paper and speciality papers. Such products as writing paper, reinforced paper, wrapping papers, paper towels, ribbons, tracing and thin papers, tablets and pads, ledger paper, lamp shade papers, and book paper are well suited to New England from the standpoint of its technological experience, skilled labor, and available raw materials. A second type of opportunity lies in the manufacture of products based largely on technological developments, such as diapers and diaper linings, printing plates, laminated building paper, and food wrappers. Resin-bonding, synthetic and natural rubbers, and new coatings applied to various materials suggest many new uses for paper products for both the consumer and industrial markets.

A new type of pulp-molding equipment is being produced by a Maine manufacturer. Although this process is still in the development stage, it will, when completed, make available low-cost, custom-molded packages offering maximum protection against impact. Such packaging may find a large market among industrial areas in New England in the electronics and machinery fields. The process utilizes reclaimed paper which is available in ample supply in New England.

Paper and Allied Products

The paper and allied products industry comprises the manufacture of pulp from wood, rags, and other fibers; the conversion of these pulps into papers and paperboard; and the manufacture of paper and paperboard into converted paper products such as coated paper, paper bags, paper boxes, cards, and envelopes.

Economic Importance

During the early years of the twentieth century, New England maintained a dominant position in the pulp and paper industry. Since 1930, however, New England's economic position in this industry has slowly declined. In 1939, Washington replaced Maine as the leading state in the wood pulp industry, and in 1947, Louisiana ranked second and Maine third. The leading areas for pulp production are now the Far West and South, with New England decreasing in importance. Production of wood pulp is listed by states for 1946 and 1947 in Exhibit 13-1.

Exhibit 13-1. Wood Pulp Production of Six Leading States

Latest bank	*State*	*Tonnage* 1946	1947
1	Washington	1,332,940	1,611,769
2	Louisiana	989,388	1,165,997
3	Maine	1,185,232	1,065,292
4	Florida	694,594	928,128
5	Georgia	422,648	890,968
6	Wisconsin	889,139	806,891

Source: U. S. Department of Commerce, Bureau of the Census, *Pulp and Paper*, June, 1951.

There are several reasons why New England has not retained a dominant position in the wood pulp industry. Other regions, especially the Far West, have more plentiful supplies of pulpwood of excellent quality. Also, pulp and paper mills are run on a much larger scale in the West and South and have more up-to-date equipment, such as high-speed machinery, resulting in more efficient, low-cost production. Furthermore, in some areas, the availability of cheap power is a decided advantage.

Although the paper industry in New England has not grown proportionately with the entire field, there has been an appreciable increase in employment. Firms engaged in converting paper to specialty products are the largest single group responsible for this growth. In the period 1939 to

Exhibit 13-2. Productivity of Paper and Paperboard Mills, 1947

	Product value f.o.b. mill per $ of wages		*Value added by manufacturing per $ wages*		*Yearly production (tons) per worker*	
	N.E.	*U. S.*	*N.E.*	*U. S.*	*N.E.*	*U. S.*
Paper mills	$6.50	$6.81	$2.16	$3.26	244	263
Paper and paperboard mills	6.37	7.39	2.46	2.75	110	164
All mills	6.40	7.24	2.40	2.88	136	190

Source: *Census of Manufactures: 1947*, as calculated by the Federal Reserve Bank of Boston.

1947, paper and allied products had a 43.8% growth in employment in the United States, while New England employment increased 30.1%. The New England workers (60,020) constitute 15.4% of the national total.

The per cent increase in value added by manufacture for the period 1939 to 1947 was 224 for the United States as compared to 185 for New England. In 1947, New England was responsible for approximately 13.8% of the total value added.

A comparison of the productivity of paper and paperboard mills in New England and the United States is shown in Exhibit 13-2. It will be noted that New England mills rank below the United States average in product value, value added, and output per worker. Exhibit 13-3 indicates that two New England states are among the first eleven in output of paper and paperboard.

Exhibit 13-3. Paper and Paperboard Production, 1947

State	*Tons*
New York	1,850,000
Michigan	1,537,000
Wisconsin	1,400,000
Louisiana	1,350,000
Pennsylvania	1,300,000
Maine	1,225,000
New Jersey	1,105,000
Washington	317,000
Illinois	776,000
Virginia	746,000
Massachusetts	742,000
Florida	663,000

Source: U. S. Department of Commerce, Bureau of the Census, *Pulp and Paper*, June 30, 1951.

Paper and paperboard production was approximately 26,120,000 tons in 1951, which is 7% above the record year of 1950. The 1951 production was nearly double that of 1939. In Exhibit 13-4, United States and New England paper and board production is shown, itemized by major grades. Newsprint, book paper, fine paper, and bending board are the most important groups for New England.

Exhibit 13-4. Paper and Board Production, 1947 (Tons)

Major grade	*United States*	*New England*
Newsprint	833,038	494,697
Groundwood	821,318	242,519
Book	2,207,923	357,181
Fine	1,171,539	313,892
Coarse	2,903,450	293,102
Special industrial	289,499	105,526
Sanitary	894,032	133,433
Tissue	194,624	
Absorbent	100,486	17,963
Container board	4,943,694	105,136
Bending board	2,757,889	302,296
Nonbending board	705,424	81,042
Special paper board stock	687,945	34,795
Cardboard	91,858	40,382
Wet machine board	149,800	44,241
Building paper	1,289,109	59,267
Building board	1,072,372	
Withheld to avoid disclosures		71,400
Total	21,114,000	2,696,872

Source: *Census of Manufactures: 1947.*

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Forward-looking industries have found Tennessee's highest quality Sulphur-Dioxide a sure side-track to successful operations. In so many cases, highly efficient and economical operations can be attained through the uses of this chemical (SO_2) with its multi-purposed versatility. In preventing color reversions, and in washing out undesirable materials from the pulp, Sulphur-Dioxide replaces or supplements burner gas, thus increasing your efficiency and productivity.

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New England is in a better position with respect to wood pulp supply than the Central States area, although the quantity and quality of its resources are relatively poor as compared to the Far West and South. Over 75% of the land in New England is forested. However, existing resources are not being utilized as fully as possible. In New Hampshire, only 40% of the annual growth of hardwood is being cut. One leading manufacturer is of the opinion that a 20% increase in wood pulp production in New England is possible. Native softwoods, such as spruce, fir, hemlock, cedar and white pine, and hardwoods of elm, cherry, white and yellow birch, poplar, maple, and beech provide a variety of woods for many uses. This diversity of woods is particularly encouraging when compared to the Southern supply which consists primarily of pine. The proximity of timber reserves in Northeast Canada has been an advantage to the industry in the past in supplying raw materials, and may continue to be in the future if Canada's own needs do not increase disproportionately.

One of the factors responsible for the limited utilization of forest resources has been the lack of a scientific forest program. Five per cent of the woodlands are owned or controlled by the various state and federal agencies, while large paper concerns, such as the Great Northern Paper Co., and others, have substantial holdings. These forests tend to be well managed, but proper forest management and reforestation methods have not been used with consistency among many private owners who are unaware of the various forestry agencies and services available to them. If New England is to take advantage of its forest reserves, a more organized program should be initiated to educate owners in modern forestry methods.

Massachusetts, Rhode Island, and Connecticut have together more than 4.5 million acres of woodland. Although the current annual growth of hardwoods on this area would support several large pulp mills using modern manufacturing methods, markets are lacking for most of this potential pulpwood yield. If good forest management were applied to all of this woodland area, the annual yield could be brought up to more than 2 million cords. However, supplies of wood in this area and proximity to markets justify further investigation of the feasibility of establishing a hardwood pulp mill to capitalize upon this opportunity.

Several factors which have contributed to New England's unfavorable competitive position in the past should be considered before concerted efforts are made to locate new industry in New England. Ideal locations for pulp plants are on rivers near the source of wood supplied, providing adequate water and water power for pulp processing, as well as transportation from the logging areas. Unfortunately, sites fitting these specifications are not plentiful in New England; most of the water rights are already taken up. Another handicap is that the cold climate restricts cutting operations and increases cutting costs, making a differential of about 5 dollars a cord over warmer climates.

New England enjoys a definite advantage over other major producing areas in being close to markets. The region's own consumption of paper products is very substantial, and the nearby New York and Mid-Atlantic markets are within easy shipping distance.

Industrial Opportunities

There are many opportunities for further industrial developments within the pulp and paper industry. Three are especially promising: specialty paper products, products based on technological developments, and products utilizing wood wastes.

New England's greatest opportunity lies in increasing production of high-grade paper and specialty papers. Such items as writing paper, reinforced paper, wrapping papers, paper towels, ribbons, tracing and thin papers, tablets and pads, ledger paper, lampshade papers, and book paper are well suited to New England's economy, from the standpoint of technological know-how, skilled labor, and raw material situation. This area in the past has been noted for its high quality specialty papers, and, if the industry keeps up with new developments in the field through continued research and experimentation, it should be able to maintain its dominant position in the field of specialty papers.

The Hollingsworth and Vose Co., located in Walpole, Mass., sets an excellent example for paper concerns in New England. The combination of competent laboratory research and management has enabled the firm to keep pace with technological developments, even with old, low-speed machinery. The firm has an extensive line of specialties, including electrical insulating, saturating, absorbent, filter, gasket, pattern, and laminated pattern papers, as well as sandpaper backing, heavy duty wallets, stencils, and coating and crepe specialties.

New England has a distinct advantage, in that the smaller paper machines now being used can meet the requirements for specialty papers and quality custom work. Actually, New England is not equipped to compete with mass production areas because of the lack of raw materials and investment required in heavy high-speed machinery.

New England should make every effort to modernize and strengthen its existing paper products plants. This effort could be supplemented by constructing small plants in the neighborhood of existing pulp and paper mills in order to upgrade the product into specialized goods of high value added. Presumably, these concerns would be sponsored by private capital and promoted by community development agencies.

Products Based on Recent Technological Developments

There are many new products and processes in the paper field which New England manufacturers should consider for further development work, and, more specifically, as additions to their product lines. The need for continued research and experimentation utilizing special skills, and the fact that these products and processes have not yet been perfected by any one supplier should make them particularly attractive.

Among the recent developments in the paper field are diapers and diaper liners, printing plates, laminated building paper, insulation paper, and food wrapping paper. Further work is being done on better utilization of fiber strength, and possibilities of increased pigmentation are being considered. Resin-bonding, synthetic and natural rubbers, and new coatings applied to various metals suggest many new uses for paper products for both the consumer and industrial markets.†

A new type of pulp-molding equipment is being produced by the Chaplin Corp. of South Portland, Me. Although this process is still in the development stage, it will, when completed, make available low-cost, custom-molded packages offering maximum protection against impact. Such packaging may find a large market among industrial users in New England such as electronics manufacturers and machinery manufacturers. The process utilizes reclaimed paper which is available in ample supply in New England.

An encouraging trend in this field has been the conversion of several mills to the use of hardwood pulp, as exemplified by the development of the Brown Co. in Berlin, N. H. Hardwoods are being used in magazine paper, kraft bags, towels, and pulp to be converted for rayon manufacture. The S. D. Warren Co., located near Portland, Me., is using mixed hardwoods since its supply of poplar has been depleted. The Great Northern Paper Co. has recently announced it is entering the kraft field for the first time, so that it may utilize its rather substantial holdings of hardwood timber.

† J. R. Calkin, "Chemical Labs Developing Many New Uses for Paper," *New York Journal of Commerce*, Sept. 4, 1951.

One of the processes which may be used for hardwoods is the neutral sulphite semichemical pulping process. This process, until recently, has had limited use because of technical difficulties and failure to meet quality standards; however, the technique now shows promise of producing higher yield and better quality hardwood pulps for both bleached and unbleached papers. Another method is the Chemigroundwood pulping process which enables groundwood pulps of unusual strength to be processed at substantial savings over regular groundwood pulps. The high yield kraft process is another alternative, making possible bleached and unbleached pulps of higher yields and strengths than those of the conventional hardwood kraft process.‡ The use of these processes and the subsequent utilization of hardwood for pulp production have significantly contributed to the recognition of the need for a re-evaluation of New England forest reserves and will certainly lead to the establishment of more hardwood pulping operations in the New England area.

Products Utilizing Lumber By-Products

One of the promising fields for industrial development is in the utilization of by-products of the lumber industry, such as sawdust and wood chips.

Developments are under way using furfural or lignin to impregnate sawdust which is molded to form a variety of products. Furfural is now commercially derived from oat hulls, but one New England paper mill is known to be considering the use of waste liquors as a source of raw material.

The manufacture of wood flour from debarked softwood and wood sawdust and shavings is also a possibility. Wood flour is used as a filler for linoleums, plastics, and dynamite, and undoubtedly has further applications in the molded products field. It is a relatively young industry and has had considerable growth since its inception, especially in the Northeast area. Some of the New England producers are Wood Flour, Inc., Wilma Wood Products Co., Plastic Materials, Inc., Congoleum-Nairn, and The Bakelite Div. of Union Carbide and Carbon. Limitations on the growth of this industry lie chiefly in New England's supplies of wood waste.

A recent study on new uses for lumber waste resulted in a machine designed to process wood waste, in continuous operation in such a way as to produce a reconstructed board with the appearance of white pine. The capacity of the machine was estimated at 10 tons per day, but due to the cost of the machine the project never was completed. Other areas covered in the study were new products by extrusion molds, reconstructed felt, kiln drying of lumber, and molding of articles which would have thermoplastic properties. Evaluation of the above studies is not within the scope of this report, but they offer areas which might prove worthy of further investigation.

Growth of the paper industry in New England is continuing, although it is not keeping pace with the national trend. The raw material situation appears to be adequate reserves are not unlimited, but offer an opportunity for further development. Primarily, there is a need for education in forestry methods and a unified program leading to better utilization of wood pulp resources. New England should concentrate on the specialty paper market, with particular emphasis on new product developments and applications of lumber by-products.

Printing and Publishing in New England

The 500-year-old printing and publishing industry comprises 30,000 establishments which had a total 1951 sales volume in excess of $5 billion. Included in this industry are such major operations as the printing and publishing of newspapers, periodicals, books, greeting cards, and pamphlets. Added to this are the multitudinous forms and packaging materials required in all industries and an unending list of printed items for the home.

Industries whose main purpose is the supply of requirements of printers include linotype, photoengraving, electrotyping, and stereotyping operations, together with bookbinding and the manufacture of printing inks. Value added by manufacture in these industries totaled nearly $500 million in 1947.

Because of its size, the multibillion dollar paper industry whose major outlet is through printing and publishing is considered in another section of this survey. However, as an example of its dependence upon printing for a sales outlet, the newsprint consumption in 1950 amounted to about six million tons.

Those service professions which are supplemental to the publishing branch of the industry, such as photography, art, and advertising, are also omitted from consideration in this section since their products are generally consumed in final form by the publisher.

Statistics on printing and publishing necessarily exclude data on the amount of printing done within user companies (mimeographed items, etc.), the total value of which is undoubtedly substantial. Also excluded are any data on printing done by the United States Government. The volume in this area is sizable as reflected by the $140 million necessary to meet the estimated obligations and expenses of the Government Printing Office and the Bureau of Printing and Engraving in 1953.

Economic Importance of the Industry

In the 1939 census the industry accounted for about 10% of the total value added by all industries and employed over 4% of the total number of production workers. By 1947 the industry declined to about 6% of the total value added by all industries, while accounting for 3.7% of the total number of production workers.

‡ H. L. Field, address before Natural Resources Council of Connecticut, Nov. 29, 1951.

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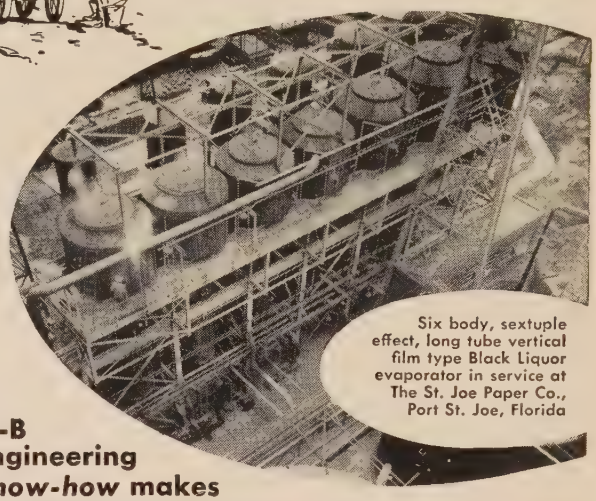

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The decline in relative position of the printing and publishing industry does not necessarily indicate a correspondingly reduced productivity. It probably reflects the results of increasingly efficient operation, particularly at the printing level and points up the narrower profit margin upon which the industry operates. For example, although Exhibit 17-1 indicates a decrease in the relative importance of newspapers, the total number of copies printed in 1947 was approximately 30% greater than in 1939, with the number of production workers increasing by only 22% in that same period. Narrower profit margins have probably been forced upon the newspapers by their reluctance to pass on the increasing costs of paper, labor, and so forth to the consumer, a policy which is a natural result of the strong competition in the industry.

There is reason to believe that productivity has increased in other sections of the industry also. In the case of periodicals, for example, circulation has increased over 50%, but the labor force has grown only 25% in the same 8-year period.

Despite this probable increase in output, the proportion of the value added by book printing and publishing to that of the whole industry has apparently increased only slightly between 1939 and 1947.

Exhibit 17-1. Value Added in Manufacture by Branches of Printing and Publishing Industry

	Value added (thousand dollars)		*Value added, %*	
	1939	*1947*	*1939*	*1947*
Newspapers	673,802	1,398,724	33.00	32.85
Periodicals	262,999	664,632	15.00	15.50
Books	128,185	320,562	7.25	7.50
Commercial printing	381,892	977,686	21.60	23.00
Lithographing	99,910	313,462	5.60	7.25
Greeting cards	24,225	81,051	1.50	2.00
Bookbinding and related industries	73,164	177,144	4.15	4.00
Printing service industries	108,577	264,004	6.20	6.20
Miscellaneous publishing	12,560	72,151	0.70	1.70
Total	1,765,314	4,269,416	100.00	100.00

Printing Processes

Typography (printing with movable type) was invented about 1440 with Gutenberg generally receiving credit. This process utilized single pieces of type and remained unchanged in principle for about 400 years, at which time Mergenthaler invented linotype, a method by which the characters in a full line of print are simultaneously cast in one piece. Monotype, the casting of a line automatically as separate characters, was patented shortly thereafter by Lanston in 1887. These mechanized methods of typesetting are now commonly employed throughout the industry.

With the development of parallel mechanization of paper manufacture by Fourdrinier in 1803 and the steam-powered rotary presses by Hoe in 1846, mechanization of printing gained impetus.

Photoengraving, the process by which a photograph is converted to a relief for typographic printing, was invented and came into some usage in the middle of the nineteenth century, Ives being considered the father of the present-day process. Up to that time, illustrations were largely handmade and consequently rather expensive.

Offset printing, or lithography, was invented by Senefelder in 1798, and uses as its basis the fact that oil and water do not mix. It has only been since about 1910 that any major advances have been made in lithography, the process now being fully mechanized and used to produce printing which is considered by some to be the highest grade of work. This printing process has found a ready outlet in art reproduction, show cards, calendars, greeting cards, books, and anywhere that single color or multicolor printing on regular, rough, or texture paper is desired.

Factors Influencing Location

Factors governing location are quite unlike in printing and publishing.

Printing: News presses are no longer run by steam, as they were in the early days of fast rotary equipment, but by electricity. However, the power demand of this industry is relatively light compared to the heavier manufacturing industries. For instance, the cost of the total energy requirements (electricity, oil, coal, and gas) for the printing and publishing industry is equal to less than 1% of its total value added.

The equipment requirements of the printing industry may vary from a single small job press valued at a few hundred dollars to several high-speed, large, automatic presses each valued at $750 thousand or more. Because of the high cost of the larger units, either typographic or lithographic, replacement is minimized by the users, who are constantly seeking new developments applicable to present equipment but which reduce cost by increasing the speed of the makeready or other steps.

Because of the complexities of modern high-speed printing, the industry calls for highly skilled labor, a fact which is reflected in the $109.50 weekly wage of a composing room journeyman printer on a Boston newspaper.

Prosperity of the printing industry in a given location is basically dependent on the other industries in the area and their abilities as income producers. Newspapers, for example, depend upon advertising, the potential effectiveness of which can be at least partially predicted by the prosperity

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The Sutherland Refiner complete continuous Beating and Refining Systems.*

SUTHERLAND REFINER CORPORATION

*U. S. Patent No. 2,654,295

TRENTON 8, NEW JERSEY

Exhibit 17–2. Production Workers in Branches of Printing and Publishing Industry, 1939 to 1947

	New England — Production workers (thousands)			United States — Production workers (thousands)		
	1939	*1947*	*% Change*	*1939*	*1947*	*% Change*
Printing						
Commercial printing	8.3	11.6	38.7	112.4	156.0	38.8
Lithographing	1.6	2.3	45.1	27.0	41.3	53.1
Bookbinding *et al.*	1.0	4.3	48.4	26.0	36.4	40.7
Printing service industries	2.1	2.6	22.0	25.2	33.6	33.1
Book printing	1.0	0.5	−50.0	7.6	9.3	22.4
Total, all printing	14.0	21.3	52.0	198.2	276.6	39.5
Publishing						
Newspapers	8.4	9.5	13.6	97.0	118.0	22.1
Greeting cards	2.2	2.3	5.3	7.5	12.7	68.2
Books (publishing and printing)	1.4	1.3	−7.1	6.2	8.1	30.7
Periodicals	1.3	1.0	−23.4	15.4	19.4	25.5
Miscellaneous	14 only	0.8	5285	0.5	3.4	619
Total, all publishing	13.3	14.9	12.0	126.6	161.6	27.6
Total, all printing and publishing	29.3	36.2	23.5	324.8	438.2	35.0

of its readers. More directly, the activity of the surrounding industries also governs that of the local commercial typographers and lithographers through requirements for business forms, advertising literature, and other printed matter. An exception to the above is found in the case of a few presses which, by virtue of superior work, attract orders from outside the region in which they are located. A further exception is found in the case of the large printers, such as Donnelly in Chicago, for whom orientation to a national market is significant.

Publishing: Newspapers, generally speaking, have no choice as to location; their principal requisite, a reading public, is fixed. However, competition between local newspapers establishes the need for professional personnel trained in the art of news collection and presentation, space selling, and so forth. The keen competition at the publishing level is in contrast to the free interchange of knowledge and service which takes place at the printing level of the industry.

The publication of periodicals requires the same skills, but competition is generally on a larger, frequently national scale. Since the outlets for periodicals cover a greater area than for newspapers, publishers tend to locate as close as possible to the circulation center of their subscribers, the location being tempered by the availability of the service professions in the creative arts which are necessary to the success of the publication. Printing facilities, on the other hand, need not be local to the publishing center and, in fact, are frequently located at some distant spot for specific purposes such as ease of distribution, lower labor and overhead costs, and so forth.

New England's Position

Printing and publishing employed 2.9% of New England production workers in 1947, compared to 3.7% nationally. In 1939, the proportions were 3.1 and 4.2%, respectively. The absolute growth in terms of New England workers employed in the printing and publishing industry between 1939 and 1947 was 25%, compared to 35% nationally.

Examination of Exhibit 17-2 indicates that, while printing has almost kept pace in New England with the national rate of growth, publishing has fallen behind.

PUBLISHING

Growth in the publication of newspapers during the 1939 to 1947 period in New England has lagged behind the national average by a considerable margin; nevertheless this branch still accounts for most of the growth in publishing which has taken place.

The publishing and the printing of greeting cards may or may not be done by the same organization. A publishing establishment may print its creations on its own equipment or employ the services of local, independent printing establishments—practices reported to be about equally divided in New England. The printing is usually done by lithography and as a consequence requires a special paper. This paper is currently obtainable from sources within New England.

The relatively minor role played by the publication of books and periodicals in New England has come about gradually over a considerable period of time, during which the then-existing publishing houses have slowly been sold to others located elsewhere, moved out, or ceased operation entirely, all without replacement. According to one source, it has been acknowledged by some of those who have left that the reason for leaving this area was because a New York or Chicago address was more fashionable. Another reason may well be that publishers of periodicals want to be close to the centers of fashion, art, society, politics, etc.

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Sutherland High Yield Kraft System*
SUTHERLAND REFINER
CORPORATION
TRENTON 8, NEW JERSEY
* U.S. Patent No. 2,591,106

Printing

The vigorous increase in bookbinding and related industries in New England as shown in Exhibit 17-2 would at first appear to be an anomaly, considering the appreciable decline in the number of book printers in this same area during the same period. The reasons for this apparent discrepancy appear to to be first, that fewer printers now specialize in books alone, and, second, the considerable number of paper-bound novels which have been sold in recent years are products of New England's commercial printers. The increase in the printing of low-priced books in this area is probably linked to the availability of paper stock, a modified newsprint being used.

Lithography, too, has benefited from the increased sales in the low-cost book field and is being used more extensively in the manufacture of hard-bound, low-priced books for children.

The printing of periodicals is firmly established in New England where several presses produce numerous trade and popular magazines of national circulation. The strength of periodical printing is based on the availability of an ample paper supply from sources in the region, relatively favorable labor costs, and the existence of flat rates for mailing to all parts of the United States.

Recent Developments

The inseparable link between publishing and printing means that publishing is most seriously affected by developments related to the latter industry. This section is, therefore, devoted to basic new equipment and methods now being introduced or soon to become available to printers in general.

TYPOGRAPHY

Composition: The bulk of typesetting today is done by machine, either linotype or monotype, each having special advantages for certain purposes. Each produces a heavy mass of set type which is assembled by hand into page form to be stereotyped, electrotyped, or used directly for printing. The equipment and processes are generally such that highly skilled labor is necessary.

Since any reduction in the need for expensive labor is of interest to the trade, there has been considerable effort in recent years to develop equipment for setting type photographically, i.e., means for the rapid, simple, mechanical preparation of a fully justified photographic reproduction of printed matter and even of a printed page by semiskilled, relatively low-cost labor. This equipment is of immediate interest to those engaged in the preparation of advertising copy where a photographic image is the end product.

Acceptance of this equipment by typographers is contingent upon the development of more rapid means of generating photographic reliefs. Currently, a relief is produced from a photographic original in from 20 to 40 minutes by highly skilled labor. In this connection, at least one new process for the preparation of metallic reliefs from photographic originals is in the final stages of development, which will, if successful, require only 6 to 7 minutes and will thus make phototypesetting especially attractive to book, periodical, and commercial printers in general.

The acceleration of photoengraving methods is also of considerable interest to the newspaper trade as a means of reducing both the over-all cost and the total time now required for the translation of a photograph to a relief. The phototypesetter does not, however, have the same attractiveness to newsmen that it might have elsewhere, since the machine composition of type gives a relief directly, thus eliminating even the 6 or 7 minutes required to obtain an equivalent relief from a photoset page.

The replacement of metal printing plates with rubber or plastic has been accelerated in recent years by new developments in oil-resistant rubbers and in plastics generally. Plastic and rubber printing plates have the advantage of lower weight, which permits higher press speeds, but their principal value lies in their resilience and the attendant reduction in makeready time and type wear. These features are of particular interest to book printers and to commercial typographers generally.

With metal type, in contrast to plastic and rubber, the pressure under which the paper is forced against the type must be carefully adjusted in order to obtain a uniform impression and minimum type wear. Although the reduction of makeready time would be of considerable interest to newspaper printers, the time required to prepare a plate is the major drawback of plastics or rubber plates in this connection. The preparation of a plastic or rubber plate from a metal form, for example, requires several minutes whereas the metal stereotype used by most newspapers can be cast at the rate of six to eight per minute.

The problem of makeready time for newspapers and other printers using metal type is, however, being somewhat alleviated by the use of a recently introduced plastic blanket. This blanket, upon which the paper rests while being pressed against the type, is a rather hard plastic which slowly deforms under pressure, and resumes its natural position equally slowly when the pressure has been removed. As a result, a blanket made of this material tends to adjust itself to the irregularities in the height of the type, and at the same time can slowly return to its original state between uses.

Newspaper printers have also shown interest in a new plastic mat which permits the reduction of page width, since it is designed to shrink, during drying, mainly along one dimension. The mat, which is the mold of the original typeset page into which the stereotypes are cast, must not shrink appreciably in length, since that dimension is fixed by the dimensions of the press, and this kind of shrinkage must therefore be compensated for by an increase in the length of the original form. Presses can, however, be adjusted to different

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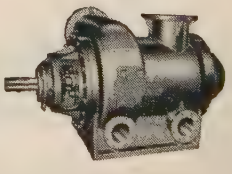

Sutherland Breaker Trap

SUTHERLAND REFINER
CORPORATION
TRENTON 8, NEW JERSEY

widths; hence any decrease in this dimension can be handled and is directly translatable into newsprint savings.

Printing. The high initial cost of printing machinery has probably been an impediment to the acceptance of advances in the printing equipment field. Hence, the main advances made in the industry have been subordinate to, and limited by, existing presses.

However, consideration has been and is being given to the possible production of books by techniques which stimulate those of newspapers, in that paper is fed into the press and bound books result at the other end. Numerous technical difficulties must be overcome, however, before equipment of this type will be generally available. It is interesting to note that one large company was interested in such a process and reputedly hired an engineer not acquainted with the printing field to consider the possibility. After becoming acquainted with the problem, the engineer devised a process for printing from rubber plates which is reported to produce impressions which are much superior to those ordinarily obtained from this kind of plate with conventional equipment.

The newspaper publishers have been quick to realize the value of research and have banded together to form the American Newspaper Publishers Association which is devoted mainly to research, with central facilities in Easton, Pa.

Time, Inc., offers another example of progressive research, having recently invested a considerable sum in an investigation of lithography as a means of printing their periodicals. Although this process was found not to be applicable to the publishing of periodicals yet, the research led to the bimetallic offset plate which is gaining acceptance by the trade for use where close color register and long runs are desired.

Lithography

Lithography, which is itself quite new, is finding more applications, especially in new or expanding businesses. Lithographic printing has been demonstrated to be superior in some respects, inferior in others, to typographic processes. As an example of superior performance, it is possible to print two sides at one time, a feat which can at least double the speed at which books can be typographically printed.

The lithographic printing process, although invented in 1798, is a relative newcomer in the field of commercial printing, since it was not until about 1910 that the process began to yield to mechanization. By 1931 there were about 900 lithographic printing establishments in the United States, and today the figure is in excess of 4000, illustrating the importance of this process.

The lithographic process is based on the fact that an oily ink and water do not mix. An oil, ink-receptive image is generated, generally photographically, upon a water-receptive base to form the printing plate. This plate, when mounted on a turning cylinder, alternately comes into contact with a wetting roll, inking roll, and a synchronized transfer cylinder which is covered with a rubber blanket. The ink image is transferred first to the rubber blanket and from there to the paper which is fed under the transfer cylinder.

Composition: At the present time, the original copy from which lithographic plates are made is composed principally of proofs or single prints from regular type forms, supplemented by machine or hand-drawn art work, photographic halftones, and in fact any material which can be photographically reproduced.

The preparation of a single proof from a regularly set type form entails all of the expense encountered up to that point in typographic printing; hence simpler, less expensive methods are being sought to produce the same result. A partial answer is being found in the use of justifying typewriters, that is, typewriters on which the spacing can be adjusted to produce lines which are all of equal length. These typewriters, which can be operated by almost any typist, are generally produced with interchangeable type faces which are similar to those now used by the printing trade. This process has the very considerable advantage in that the typing can be applied directly to a paper lithographic plate which in turn can be placed directly upon the press. Although these typewriters are simple and relatively inexpensive to operate, they are still not the answer to the requirements for high quality, as established by the book trade and others.

The phototypesetter mentioned above in connection with typography may provide the ideal solution to the problem of procuring high-quality, low-cost copy for lithographic plates since it, too, requires only a semiskilled operator, and the resultant copy closely approximates a photographic copy of a typeset original.

Phototypesetting has the added advantage of producing the copy directly upon photographic film, thus eliminating one operation. One local manufacturer of this equipment indicates that, although some hand labor is necessary now to make corrections and to assemble pages, the process will shortly be entirely mechanized.

Until recently, the lithographic plates were limited to about 100,000 impressions, more or less, depending on a number of factors. This deficiency is being overcome by the use of bimetallic plates which are being favorably received by the trade. In this process an image of the copy to be printed is photographically generated on an ordinarily ink-receptive copper plate, the nonprinting areas being electrolytically coated with a water-receptive, porous, hard chrome film.

The process fits in well with conventional lithographic practice, except for the requirement of plating equipment. Fortunately this type of equipment is currently available in those shops devoted to electrotyping and widespread acceptance of these plates might easily become a sizable supplement to the regular products of this branch of the industry.

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PRESSURE WASHING

Sutherland Inc. Pressure Washing*
Sold and Serviced by

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TRENTON 8, NEW JERSEY

*U. S. Patent No. 2,355,091

Several factors enter into the speed at which printing presses can be operated. In the short run, small press field, lithography has gained upon typography, since the cylindrically applied impression of the former permits relatively continuous feed and hence higher press speeds than the intermittently fed equivalent typographic "job" press.

At the other end of the scale, however, the situation is reversed. The speed of web-fed rotary typographic presses is limited only by the rate at which the paper can be handled. Lithographic presses have the disadvantage that at higher speeds the amount of water transferred to the plate and thence to the paper increases and eventually reaches a point where the strength of the paper web is impaired.

There are indications, however, that this major limitation is about to be removed with the introduction of a newly devised method for the removal of the excess water before it can be transferred to the impression blanket. This is accomplished by utilizing a "knife" of air to scrape the excess moisture off the plate just prior to its contact with the blanket. It is claimed that the effects of this process are twofold: not only can the paper speed be increased but also cleaner impressions are obtained, since the excess water is swept off the printing areas as well. This process is expected to permit about 36,000 impressions per hour as compared to the 40,000 now obtainable upon news presses.

The field of lithography offers much possibility for future advancement. It was stated in about 1939 that this comparatively new field had developed to a point well in advance of the craftsmen in it.

Because of the simplicity, speed, and relatively low cost of small lithographic printing machinery and because only semiskilled labor is required, installations for the printing of business forms are becoming increasingly numerous in other nonprinting industries.

Printing of greeting cards is usually done by lithography. The increase in the number of production workers in this activity as indicated in Exhibit 17-2 and the discussions in the previous paragraphs suggest the possibility for increased activity in New England. Considerable advancement would also be contingent upon the future availability locally of the semispecial paper required for this type of printing. Currently, publishers are meeting no difficulties in obtaining book paper.

The printing industry in New England appears to have captured at least a portion of the low-cost printing field, since it is ideally suited to this type of work. The equipment, man power, and particular paper required are readily available.

An important factor in the local growth of commercial printing may well be the relatively recent spurt in printing research which is rapidly developing here and which in effect would make New England the proving ground for and first recipient of advanced ideas in typography and lithography.

Finally, the printing of periodicals offers a favorable opportunity for growth, especially in monthlies and trade magazines, where timing of distribution is not of prime importance. Here, the chief advantages for New England are its favorable labor costs, the availability of ample sources of paper within the region, and the fact that uniform postage rates take publications to all parts of the country at the same mailing costs as are experienced by competitors in other regions.

Southern Paperboard High Yield Expansion

George E. Dyke, President of Robert Gair Co., Inc., New York, manufacturers of paperboard, folding cartons and shipping containers, announces the completion of a 2-year $5,000,000 extension program at the kraft container board mill of its subsidiary, Southern Paperboard Corp., Port Wentworth, Ga.

Mr. Dyke said, "Recently great strides have been made in the technology of the production of kraft board resulting in important improvements in quality and uniformity, in better utilization of pulpwood, and in higher production rates. The mill of our subsidiary, Southern Paperboard Corp., is a typical example of this advance. When completed in June 1948 at a cost of approximately $16,700,000 this mill included the most up-to-date methods and equipment available at that time. Yet scarcely 4 years later in order to take full advantage of the advance in techniques and to make other improvements, this extension program was entered into."

The $5,000,000 addition to the chemical and mechanical facilities of this mill has been completed within the estimated expenditure and with a minimum loss of operating time. Daily capacity has been increased to a maximum of 685 tons of finished paperboard, a substantial increase over the original capacity of the mill. Operations to date show improved quality with an important reduction in the amount of pulpwood used per ton of paperboard.

Wood Preparation

A check of the existing wood handling and wood preparation equipment revealed that no additions were required, since the pulp production expected from the high yield from the wood would provide sufficient furnish for the increase in finished product. The chip storage and handling facilities were also adequate for serving the new digesters.

Causticizing

To supplement the existing Dorr causticizing plant, a new lime storage bin was installed, this to be fed from a Jeffrey lime track unloading hopper, drag conveyer, and bucket elevator.

A new No. 10 Dorr lime slaker, with new and reburned lime feeders, was provided outdoors adjacent to the present slaker building.

An additional lime mud storage tank with agitator and a white liquor storage tank were found necessary.

Digesters

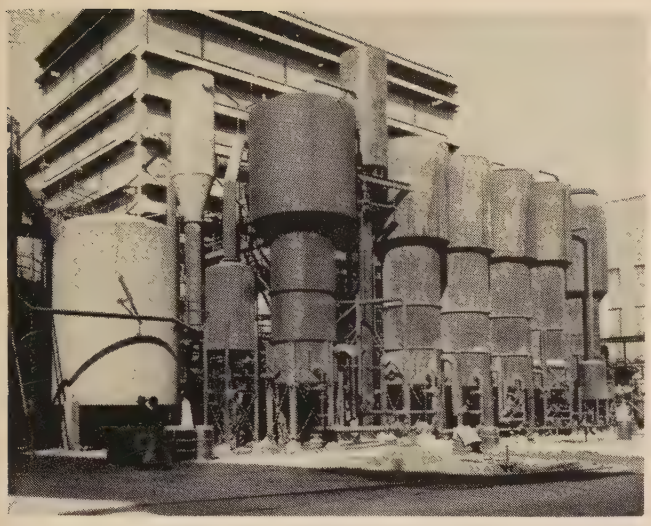
A 29 by 76-ft. extension was added to the digester building to house four new 3320 cu. ft. carbon steel Chicago Bridge & Iron Co. digesters, each equipped with a gas-off separator and Paul hydraulically controlled blow valve.

For feeding chips to the four new and the six old digesters, a new shuttle belt conveyor centered over the digesters and hung from overhead tracks was installed by the Montague Machine Co. The shuttle belt was fed from the old chip conveyor.

A new black liquor measuring tank was added for supplying charges of black liquor to both the new and old digesters.

Piping changes in the blow lines were rearranged so that the old digesters could be connected to one of the existing blow tanks, and the new digesters to the other present blow tank.

View of the Southern Paperboard Corp. plant at Port Wentworth, Ga.



Evaporators at Southern Paperboard

Washing and Screening

To house the additional washers, screens, dockers, and refining equipment, the present wash and screen room was extended for a width of 57 ft.; the length of the two rooms being approximately 155 ft.

Three Oliver United 11-ft. 6-in. diameter by 16-ft. long vacuum washers with intermediate repulpers and final repulper were installed on the operating floor of the wash room, with space provided for a fourth future washer if desired. Three Claflins were placed ahead of these new washers.

Stock is being furnished from the existing pumps, which have been equipped with variable speed couplings.

To protect the Claflins, permanent type magnetic separators were supplied in the stock lines.

A 16-ft. diameter steel horizontal filtrate tank has been provided for each washing stage, with the necessary black liquor dilution pumps. The tanks are connected by foam lines to a 20-ft. diameter by 60-ft. high steel foam tower; the latter and strong black liquor filtrate tank each being equipped with an Oliver United foam breaker.

This new washing equipment supplements the old four-stage, Line "A," 8-ft. diameter by 14-ft. washers and the three-stage, Line "B," 8 by 10-ft. washers. The pre-knotters, formerly used ahead of these washers, have been by-passed and stock conditioning is now being done by two Claflins for each line. These are also protected from injury by tramp metal with permanent type pipe-line magnets.

Over the new line of washers a J. O. Ross Engineering Corp. hood has been installed, with fans for exhausting vapors to outdoors.

Stock from the new washers and the present Line "A" washers is normally to be discharged at high density (provision has also been made for low density storage to existing chests if desired). The H.D. stock is to be taken by a Link-Belt Co. rubber belt conveyor to a 33-ft. diameter by 60-ft. high steel high density storage tank outside of the building, which has been furnished with Improved Machinery agitation and dilution equipment.

Between the washed stock storage tanks and screening equipment, seven Sprout-Waldron single disk refiners, each driven by a 450-hp. motor, have been installed. The consistency of the stock to these refiners will be controlled by DeZurik pressure type regulators.

Four new Improved Machinery centrifugal screens have been added to the eight present screens. The new screens are provided with agitated mix box, flow box, and poppet type inlet valves.

For thickening the screened stock and also to serve as savealls for the paper machine white water, two Oliver United 8-ft. diameter by 16-ft. vacuum deckers were purchased. The stock from these deckers is to be discharged into a new Chemical Linings tile storage chest equipped with IMPCO agitators. The white water from the savealls is to be collected in a tile chest and used for dilution water as required in the stock preparation system.

Rejects from the centrifugal screens are to be pumped over a Sprout-Waldron drainer, then refined through an existing disk refiner of the same make prior to being returned to the centrifugal screens for further screening.

Paper Machine

The following changes were necessary to the paper machine and auxiliaries:

The steam pressure to the driers was increased to 70 p.s.i.; two additional Nash vacuum pumps were provided for the couch roll; separators and condensate pumps were added by Midwest-Fulton for the Drier Drainage System; additional agitator and stock pump were furnished for the couch pit; and three exhaust fans added by Jamar-Olmen to the paper machine hood. An additional supply fan was also required for make-up air.

Deculators have also been installed for deaerating stock to the primary and secondary headboxes.

Evaporators

A new six-effect self-supporting Conkey evaporating unit, built by General American Transportation Corp., equipped with barometric condenser, flash tanks, and Worthington liquor and condensate pumps has been added to the present multiple effect black liquor evaporators.

In connection with the evaporator unit a soap skimming tank, with Link-Belt skimmer, and a concentrated black liquor storage tank were required.

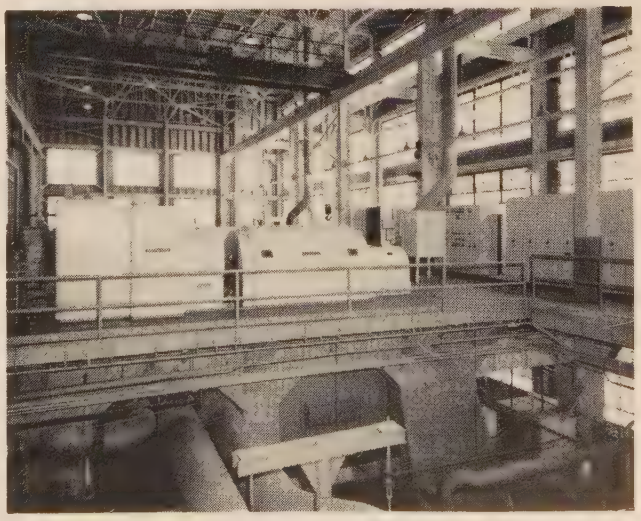
Power Plant

To provide the additional steam required for the mill expansion a new 160,000-lb. per hour Combustion Engineering power boiler was added. This unit is equipped for either oil or gas firing, with provision for conversion to pulverized coal in the future.

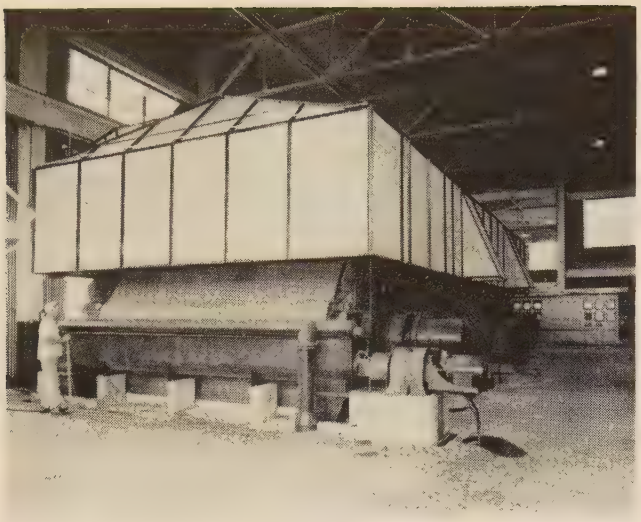
Auxiliary boiler room equipment added to complete the boiler room expansion consisted of a boiler feed pump, make-up pumps, feedwater heater, chemical feed pump, combustion, and feedwater controls.

To provide for the additional power required by the mill expansion, a new General Electric Co. 10,000-kw. maximum capability turbo-generator was installed in the turbine room. This is a double automatic extraction, condensing machine equipped with a Westinghouse Corp. condenser and auxiliaries.

In addition, the existing Westinghouse turbo-generators were altered so that the noncondensing turbine exhausts at



The turbine room



The black liquor washers

and the condensing turbine extracts at 80 p.s.i.g. instead of the previous 50 p.s.i.g. At the same time the condensing Westinghouse turbine was altered to increase its maximum capacity from 6000 to 7500 kw.

General

The high yield expansion program was directed by C. S. Huestis, vice-president of Southern Paperboard Corp., in conjunction with the mill staff headed by Charles McCarthy, vice-president, and assisted by Claude Adams, production manager, and Bruce Ellen, power and pulp mill superintendent.

J. E. Sirrine Co. of Greenville, S. C., were retained as engineers for the complete detailed design and supervision of construction.

The entire construction program was consummated by obtaining firm bids for the various portions of the work, the principal contractors and vendors of equipment being as shown on the following list.

Principal Contractors:

Brooks Fisher Insulating Co., Atlanta, Ga., piping insulating
Byck Electric Co., Inc., Savannah, Ga., electrical installation
Byck-Worrell Construction Co., Savannah, Ga., site preparation
Clausen-Taylor Marine Construction Co., Savannah, Ga., temporary building
Daniel Construction Co., Greenville, S. C., building contractor
Grinnell Co., Inc., Atlanta, Ga., process and power piping
Hall Steel Co., Atlanta, Ga., reinforcing steel
Ledbetter Erection Co., Birmingham, Ala., equipment erection
North Brothers, Knoxville, Tenn., equipment insulation and protective coating
O'Neal Steel Works Co., Birmingham, Ala., structural steel
Raymond Concrete Pile Co., Atlanta, Ga., piling

Principal Suppliers of Mill Equipment:

Allis-Chalmers Mfg. Co., Milwaukee, Wis., pumps
American Blower Corp., Detroit, Mich., oil coolers and couplings
Chemical Linings, Inc., Watertown, N. Y., tile chests
Chicago Bridge & Iron Co., Chicago, Ill., tanks, digesters
Clark & Vicario, Bronxville, N. Y., instruments and controllers for vapor circulating system
Cole, R. D., Mfg. Co., Newnan, Ga., miscellaneous tanks
Combustion Engineering, Inc., New York, N. Y., power boiler
De Zurik Shower Co., Sartell, Minn., consistency regulators
Dorr Co., Stamford, Conn., causticizing equipment
The Emerson Mfg. Co., Lawrence, Mass., prebreakers
Equitable Equipment Co., New Orleans, La., miscellaneous tanks and chutes
Eriez Mfg. Co., Erie, Pa., magnetic separators
Foxboro Co., Foxboro, Mass., instruments
General American Transportation Corp., New York, N. Y., evaporators
General Electric Co., New York, N. Y., motors and turbogenerator
Goulds Pumps, Inc., Atlanta, Ga., pumps
Greenville Steel & Foundry Co., Greenville, S. C., valves
Griscom-Russell Co., Greensboro, N. C., closed feedwater heater
Holt Equipment Corp., Jacksonville, Fla., American Chain & Cable Co., crane
Improved Machinery, Inc., Nashua, N. H., repulper conveyor, H.D. storage agitator and equipment, poppet valves, centrifugal screens, agitators
Ingersoll-Rand Co., Birmingham, Ala., pumps
Jamar-Olmen Co., New York, N. Y., paper machine hood exhaust
Jeffrey Mfg. Co., Columbus, Ohio, lime conveying and auxiliary equipment
Koppers Corp., New York, N. Y., couplings
Link-Belt Co., Atlanta, Ga., belt conveyors, soap skimmer
Midwest-Fulton Mch. Co., Dayton, Ohio, vapor circulating system
Milton Roy Co., Philadelphia, Pa., chemical pump
Montague, B. L., Co., Sumter, S. C., shuttle chip conveyor
Moore, Samuel, & Co., Mantua, Ohio, copper tubing
Nash Engineering Co., South Norwalk, Conn., vacuum pumps
Oliver United Filters, Inc., New York, N. Y., Brown stock washers, foambreakers, savealls
O'Neal Steel Works Co., Birmingam, Ala., supports
Paul Valve Corp., New York, N. Y., blow valves
Powers Regulator Co., Atlanta, Ga., steam regulator
Republic Flow Meters Co., Atlanta, Ga., feedwater regulator and control system
Robinson, John D., Co., Savannah, Ga., New York rubber conveyor belting
Ross, J. O., Engineering Corp., New York, N. Y., washer hood and exhaust
Savannah Iron & Wire Works, Savannah, Ga., miscelleous steel
Savannah Machine & Foundry Co., Savannah, Ga., stacks and breeching
Spotswood Parker Co., Atlanta, Ga., boiler flame control
Sprout-Waldron & Co., Muncy, Pa., refiners and reject drainer
Viking Pump Co., Cedar Falls, Iowa, soap pump
Westinghouse Electric Corp., New York, N. Y., motor controls, surface condenser, and hot well pumps
Worthington Corp., Atlanta, Ga., pumps

NEPCO

Nekoosa-Edwards Paper Co., Port Edwards, Wis., gave a 35-acre planted forest plot to a Nekoosa High School 5 years ago. Harvesting pulpwood from this land provides education in wild life conservation and forestry management to members of the school's conservation club, and provides them with money for educational trips.

Nepco is experimenting with chemical debarking of scrub oak in Central Wisconsin. The method used consists of girdling the tree with the back of an axe and applying a solution of sodium arsenite.

To improve quality and increase safe operating speed, no. 1 machine at Nekoosa has been extensively rebuilt and is now back in operation.

The fourdrinier was rebuilt by Beloit Iron Works to incorporate a new split shaking table roll section with an additional shake unit. Effective forming space of the machine was increased by rebuilding the suction box section and moving it closer to the suction couch roll. Other features include practically all new framework, new roll stands, and additional saveall pans.

A new tile, concrete reinforced couch pit, similar to that provided on no. 4, was installed by the Chemical Linings, Inc., to handle couch broke during start-ups and breaks. The pit was also equipped with a new E. D. Jones agitating apparatus and a Gould vertical-type stock pump. The machine pit proper was revamped and partially tile-lined by Nepco's own crew.

The first press suction roll was reconditioned and its shell was re-rubber covered by the Cincinnati Rubber Co. and re-drilled by the Sandusky Foundry and Machine Co. A new Beloit air-operated felt guide was installed on the second press felt.

The entire drive system was overhauled and a new Elliott turbine added to handle the power requirements at the new higher speeds. Many new high-speed pulleys, a new Beloit air operated main section drier clutch, and some new W. A. Jones gear changes were installed to improve the power transmission system, and increase its capacity.

Along with all of the above, the machine was completely

realigned from its Valley stock entrance equipment to the reel and much of the foundation structure was reinforced and leveled. Many pumps and considerable piping were relocated to improve the stock and white water systems. Also numerous felt and paper rolls were reconditioned and equipped with new antifriction bearings. A new power console was added at the press section to consolidate wet end controls.

As a final touch, the complete machine and machine room walls were cleaned and painted with pleasant contrasting colors to improve appearance.

Through cooperative efforts of maintenance, power departments, and others, the machine was started up in a very satisfactory manner 37 days after shutdown.

Champion

Walter J. Damtoft of the Champion Paper and Fibre Co. has been awarded the honorary degree of Doctor of Forest Science by North Carolina State College.

Charmin

Charmin has passed the halfway mark in building its torula yeast plant, and expects to be operating before the end of 1954.

Charmin Paper Mills, Green Bay, Wis. is disposing of 50% of its spent sulphite liquor for use as roadbinder. The liquor is given free of charge to public authorities.

Paterson

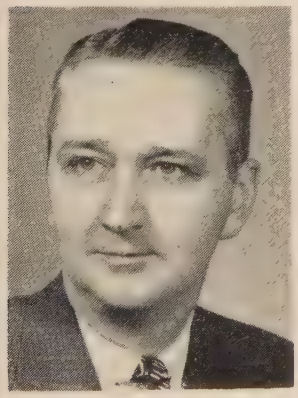
Four changes in the papermaking department personnel have been made by the Paterson Parchment Paper Co., Bristol, Pa. Arthur Gould has been appointed advisory superintendent of the papermaking department, Robert D. Robinson is superintendent of papermaking, Edward A. Wodka is technical assistant superintendent, and Henry Borneisen is assistant superintendent.

Consolidated

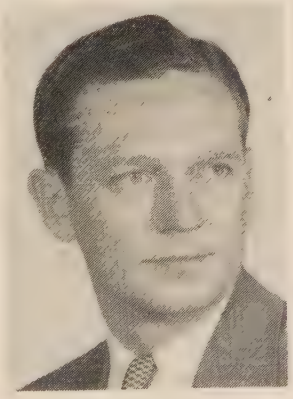
Consolidated Water Power and Paper Co., Appleton, Wis., has installed a 16,000-gallon concrete tank to be used for neutralizing concentrated spent sulphite liquor from the company's Interlake mill. The tank is equipped with circulating pumps for agitation.

Sorg

L. C. Currier has been elected vice-president in charge of development and engineering of the Sorg Paper Co., Middletown, Ohio. Carl H. Eisenmenger has been appointed manager of the Sorg mill.



L. C. Currier, Sorg Paper Co.



C. H. Eisenmenger, Sorg Paper Co.

St. Regis (Canada)

Earl P. Engness has been appointed general superintendent of bag manufacturing for St. Regis Paper Co. (Canada), succeeding Joseph M. Harnit, Sr., who has retired. W. M. McCurdy is now western manager, and Cecil Sherwin is plant superintendent of bag manufacturing at Vancouver, and B. G. R. Cotterill is western sales manager.

Left to right: J. C. Marvin, Bulkley, Dunton Co., Inc., A. C. Biza, Storrs & Bement Co.; C. H. Reeves, Carter, Rice and Co., Corp.; and J. O. Bulkley, Bulkley, Dunton Co., Inc.

Gair

Frank J. Sullivan has been appointed manager of the Ohio Corrugated Box Division of the Robert Gair Co. at Cleveland, Ohio.

C.Z.

Crown Zellerbach Corp. has installed a hydraulic barking system at its West Lynn, Ore., mill, using an 800 g.p.m. Bingham pump to supply water at 1400 p.s.i. via welded piping using Tube-Turn SF welded couplings.

Powell River

Powell River Co., Vancouver, B. C., has acquired a controlling interest in Martin Paper Products, manufacturers of corrugated boxes with plants at Winnipeg, Calgary, and Edmonton.

Scott

George J. Lockbaum has been appointed paper mill superintendent at Scott Paper Co.'s Everett, Wash., plant.

Scott's scholarship program has been expanded to include Cornell University and the Wharton School of the University of Pennsylvania. A Scott faculty fellowship has also been established at the University of North Carolina for 1954–55, enabling a faculty member to spend a year in the executive offices of the Scott Paper Co.

Scott has been named the best managed company in the paper and allied products industry by the American Institute of Management.

Storrs & Bement

Storrs & Bement Co., division of Carter, Rice and Co., has opened a new office and warehouse in Hartford, Conn.

Bowaters

Listed below are the contractors and equipment suppliers who have participated in the construction of or supplied equipment for the new Bowaters Southern Paper Corp. mill at Calhoun, Tenn.:

Fraser Brace & Roane-Anderson, New York, N. Y.—General Contractor

Subcontractors:

Alabama Cement Tile Co., Birmingham, Ala.—precast roof slabs

Alabama Painting & Roofing Co., Fairfield, Ala.—painting struc. steel
Asbestos Erectors, Inc., Bound Brook, N. J.—asbestos roofing and siding
Automatic Heating & Equip. Co., Knoxville, Tenn.—ventilating and heating filtration plant
Bailes-Sey Contractors, Inc., Jacksonville, Fla.—railroad sidings (installation)
Balton & Cummings, Inc., Nashville, Tenn.—house mark and letters
Bethlehem Steel Co., Bethlehem, Pa.—structural steel
Brice Building Co., Birmingham, Ala.—facilities building
Caldwell & Posey, Charleston, Tenn.—haul for backfill
Cooney Brothers Co., Tarrytown, N. Y.—concrete
Ceco Steel Products Corp., Birmingham, Ala.—reinforcing steel
Chattanooga Steel Erectors, Chattanooga, Tenn.—placing reinforcing
Currin Co., Chattanooga, Tenn.—fire doors
Cyclone Fence, Div. of American Steel & Wire, Charlotte, N. C.—fencing
Eichleay Corp., Pittsburgh 3, Pa.—erecting equip.; driving sheet piling
Elevator Service Co., Knoxville, Tenn.—erecting freight elevators furnished by Southern Elevator Co.
Emmett, Tom, Knoxville, Tenn.—cement finishing
Fischbach & Moore, Inc., Atlanta, Ga.—electrical installation
Grinnell Co., Inc., Atlanta, Ga.—process piping
Grinnell Co., Inc., Chattanooga, Tenn.—underground sprinkler piping; sprinkler system, mulsifyre system for protection of transformers and circuit breakers at grinder substation
Gunite Construction Corp., New York, N. Y.—lining log pond
Hailey, W. L., & Co., Inc., Nashville, Tenn.—pumping station and filtration plant electrical work—filtration plant
Hale & Wallace, Inc., Chattanooga, Tenn.—toilet partitions and tile floors
Hauserman, E. F., Co., Cleveland, Ohio—office partitions
Herb Hairell Drilling Co., Athens, Tenn.—well drilling
Knobloch & Co., Houston, Tex.—finished painting of equipment and building items
Marshall, Jake, Chattanooga, Tenn.—sanitary plumbing
Miller, J. L., Chattanooga, Tenn.—lath and plaster work
Oman Construction Co., Nashville, Tenn.—water lines and sewers; grading; raw water supply main
Parks, T. U., Chattanooga, Tenn.—foundation for butler buildings
Pennsylvania Wire Glass Co., Philadelphia, Pa.—corrugated glass panels
Penuel, A. G., Jr., Atlanta, Ga.—butler buildings
Raymond Concrete Pile Co., New York, N. Y.—piles and driving
Southern Blow Pipe & Roofing Co., Chattanooga, Tenn.—air conditioning and heating
Southern Fireproofing Co., Cincinnati, Ohio—brick and tile
Southern Railway System, Knoxville, Tenn.—railroad siding (materials)
Standard Iron & Wire Works, Chattanooga, Tenn.—machine guards
Tri-State Roofing Co., Knoxville, Tenn.—roofing and waterproofing

Principal Suppliers of Mill Equipment:

Allis-Chalmers Mfg. Co., Milwaukee, Wis.—vibrating screens, pumps and texrope drives
American Meter Co., Inc., Philadelphia, Pa.—meters
American Monorail Co., Cleveland, Ohio—ash handling system
Appleton Machine Co., Appleton, Wis.—centrifugal pulp screens, rewinder
Askania Regulator Co., Chicago, Ill.—consistency regulators
Bailey Meter Co., Cleveland, Ohio—combustion control
Beloit Iron Works, Beloit, Wis.—newsprint machines, winders
Bird Machine Co., South Walpole, Mass.—Bird screens, dirtecs
Bristol Co., Birmingham, Ala.—instruments
Bristol Metal Products Corp., Bristol, Tenn.—misc. tanks and chutes
Brooks Equipment & Mfg. Co., Knoxville, Tenn.—load lugger
Broughton, A. R., & Co., Glens Falls, N. Y.—vacuum control systems
Buckman Laboratories, Inc., Memphis, Tenn.—slime measuring units
Carolina Steel & Iron Co., Greensboro, N. C.—turntables
Carthage Machine Co., Carthage, N. Y.—chipper
Chain Belt Co., Milwaukee, Wis.—log and chip conveyors
Chattanooga Boiler & Tank Co., Chattanooga, Tenn.—misc. tanks, boxes and chutes
Chicago Bridge & Iron Co., Chicago, Ill.—shop built and field erected tanks
Cochrane Corp., Philadelphia, Pa.—demineralizer, blow-off equipment
Coen Co., San Francisco, Cal.—pump sets
Combustion Engineering, Inc., New York, N. Y.—power boilers, bark boiler, recovery furnace
Continental Equipment Co., Coraopolis, Pa.—valves
Daniel Orifice Fitting Co., Houston, Tex.—orifices
DeLaval Separator Co., New York, N. Y.—oil purifiers and paper machine oil system
Dempster Brothers, Knoxville, Tenn.—carloaders
Despatch Oven Co., Minneapolis, Minn.—oven
Dezurik Shower Co., Sartell, Minn.—consistency regulators
Dings Magnetic Separator Co., Milwaukee, Wis.—chip magnets
Dixie Mill Supply Co., Inc., New Orleans, La.—machine tools
Dorr Co., Stamford, Conn.—causticizing equipment, clarifier
Duriron Co., Dayton, Ohio—hydraulic ejector, pumps
Earl Paint Co., Utica, N. Y.—tank insulation and protective coating
Eastwood-Nealley Corp., Belleville, N. J.—suction box conditioner
Elliott Co., Charlotte, N. C.—strainers
Equipment, Inc., Atlanta, Ga.—vertical pumps
Equitable Equipment Co., New Orleans, La.—stacks and breeching, misc. tanks
Eriez Mfg. Co., Erie, Pa.—pressure magnetic humps
Fairbanks-Morse & Co., Chicago, Ill.—pumps
Falk Corp., Milwaukee, Wis.—motoreducers
Farrel-Birmingham Co., Inc., Ansonia, Conn.—roll grinder
Fibre-Making Processes, Inc., Chicago, Ill.—barking drums
Fischer & Porter Co., Kingsport, Tenn.—instruments
Foster-Wheeler Corp., New York, N. Y.—blow heat and turpentine recovery systems
Foster & Woods, Inc., Nashville, Tenn.—chip blowing system
Foxboro Co., Foxboro, Mass.—instruments
Fuller Co., Catasauqua, Pa.—airveyor systems
General Electric Co., Chattanooga, Tenn.—motors, cable, transformers, paper machine drives, turbo-generators, control equipment
General Railway Signal Co., Rochester, N. Y.—track retarders
General Steel Tank Co., Inc., Birmingham, Ala.—H_2SO_4 tank
Goslin-Birmingham Mfg. Co., Inc., Birmingham, Ala.—evaporators
Graver Water Conditioning Co., New York, N. Y.—deaerator heater
Hamilton, J. L., Engr. Co., Charlotte, N. C.—kiln lining
Hanchett Mfg. Co., Big Rapids, Mich.—knife grinders
Harris, R. L., Inc., Knoxville, Tenn.—pulpwood rake
Howe Scale Co., Rutland, Vt.—truck scale
Hydraulic Machinery Co., Ltd., Montreal, Canada—stock proportioners
Hydro Silica Corp., Gasport, N. Y.—hydro oil pressure cleaner
Improved Machinery, Inc., Nashua, N. H.—Brown stock washers and preknotter, valveless vacuum thickeners, bleachery equipment and washers, feltless wet machine, groundwood deckers, savealls, vibratory screens, agitators
Ingersoll-Rand Co., Birmingham, Ala.—pumps, air compressors
Jefferson Foundry Co., Birmingham, Ala.—cable conveyor equipment
Jeffrey Mfg. Co., Columbus, Ohio—hammer mill, rotary chip feeders
Jones, E. D., & Sons Co., Pittsfield, Mass.—jordans, broke machinery disintegrators
Keystone Engineering Co., Inc., River Rouge, Mich.—core cutter
Lamb-Grays Harbor Co., Hoquiam, Wash.—pulp cutter, layboy and conveyors
Lamson Corp., Syracuse, N. Y.—paper roll conveyors
Laurel Machine & Foundry Co., Laurel, Miss.—extractor plates and frames, misc. tank and boxes
Link-Belt Co., Atlanta, Ga.—traveling screens, belt tripper, log feeders, turntable machinery, screw conveyor, log stackers, cable conveyor machinery, soap skimmer, limestone handling system, gantry cranes
Lumus Co., New York, N. Y.—closed feedwater heater

Manning, Maxwell & Moore, Inc., Muskegon, Mich.—overhead cranes and paper reel cranes
May, Stephen C., Atlanta, Ga.—suction heaters
Merrick Scale Mfg. Co., Passaic, N. J.—weightometer
Midwest-Fulton Machine Co., Dayton, Ohio—vapor circulating systems
Miller Hofft, Inc., Richmond, Va.—bark feeder
Milton Roy Co., Philadelphia, Pa.—boiler chemical feed system, pumps
Mixing Equipment Co., Inc., Rochester, N. Y.—mixers
Montague Machine Co., Turner Falls, Mass.—grinders and aux.
Murray, D. J., Mfg. Co., Wausau, Wis.—digester stock samplers
Nash Engineering Co., South Norwalk, Conn.—vacuum pump
National Conveyor & Supply Co., Chicago, Ill.—car shaker
Noland Co., Chattanooga, Tenn.—Quaker conveyor belting
North Brothers, Knoxville, Tenn.—equipment and piping insulation
Norton Co., Worcester, Mass.—pulp stones
Oliver United Filters, Inc., New York, N. Y.—slurry pumps
Omega Machine Co., Providence, R. I.—continuous bleach lime slaker
Orville Simpson Co., Cincinnati, Ohio—chip screens
Patterson-Kelley Co., Inc., East Stroudsburg, Pa.—hot water heater
Pittsburgh Lectrodryer Corp., Pittsburgh, Pa.—air drier
Postell, J. A., Atlanta, Ga.—hydraulic equipment
Purser & London, Inc., Charlotte, N. C.—Heat Exchanger
Reliance Electric & Engineering Co., Cleveland, Ohio—pulp drier drive
Robbins & Myers, Inc., Springfield, Ohio—Crane and hoist
Roberts Filter Mfg. Co., Darby, Pa.—water treatment plant equip.
Ross, J. O., Engineering Corp., New York, N. Y.—pulp drier, washer and machine hoods, heating and ventilating systems
Sarco Co., Inc., New York, N. Y.—strainers
Savage, W. J., Co., Knoxville, Tenn.—butting saw and conveyor
Simplex Wire & Cable Co., Cambridge, Mass.—conductors
Sonoco Products Co., Hartsville, S. C.—core making machinery
Southern Corp., Charleston, S. C.—Owen pulpwood grapple and chip bucket
Southern Elevator Co., Greensboro, N. C.—building elevators
Sprout-Waldron & Co., Muncy, Pa.—refiners
S & S Machinery Co., Brooklyn, N. Y.—machine tools
Stebbins Engineering & Mfg. Co., Watertown, N. Y.—tile chests and lining
Toledo Scale Co., Toledo, Ohio—scales
Torrey Roller Bushing Works, Bath, Me.—observation manholes
Transall, Inc., Birmingham, Ala.—belt conveyor machinery
Traylor Engineering Co., Allentown, Pa.—lime kiln and auxiliaries
Trimbey Machine Works, Glens Falls, N. Y.—metering stuff boxes
Viking Pump Co., Cedar Falls, Iowa—rotary pumping units
Warren Steam Pump Co., Warren, Mass.—pumps
Washington Iron Works, Seattle, Wash.—pump baling press
Waterville Iron Works, Waterville, Me.—chip crusher
Wellman Engineering Co., Cleveland, Ohio—pulpwood grapple
Western Precipitation Corp., Los Angeles, Calif.—Cottrell precipitators
Westinghouse Electric Corp., Chattanooga, Tenn.—welding machines, motors, surface condensers, transformers, control centers, water coolers
Whitlock Manufacturing Co., Hartford, Conn.—chlorine vaporizers
Williams Patent Crusher & Pulverizer, St. Louis, Mo.—bark shredder
Williams & Wilson, Ltd., Montreal, Canada—paper roll handling equip., roll wrapping machine
Worthington Corp., Atlanta, Ga.—pumps
Yarnall-Waring Co., Atlanta, Ga.—digester blow valves

Equitable

An enterprising maker of paper bags has developed a $150,000 machine for making them large enough to accommodate rolls of carpeting, rock wool batts, and other commodities usually wrapped with paper or boxed before storage or shipment. The new machine makes one and two-ply kraft-paper bags that can enclose objects up to 167 in. long by 74 in. in girth.

Made by the Equitable Paper Bag Co., Long Island City, the bags are delivered by the machine in flat or gusseted form with any desired lettering or design printed on them in one or two colors.

Advantages of the extra-long bags are: they reduce the time needed for wrapping or boxing by the usual methods; they are lower in cost than paperboard boxes, crates, or other packing devices; they reduce labor costs and plant space devoted to packing.

Brunswick

Completion of research facilities by the Brunswick Pulp & Paper Co., Brunswick, Ga., marks the beginning of the company's forest utilization program to assist its woodlands division to determine best management methods in growing superior trees for pulpwood.

Personnel to date include George Ference, forester, and Tom Gilles, technical production man.

Equipment for the testing of different species and types of wood for their pulpmaking qualities includes a digester, blow-tank, screen, and bleaching vessesls—everything necessary for small-scale duplication of the pulping and bleaching processes.

National Container

Approximately 60,000 sq. ft. of manufacturing space and new equipment have been added to the Los Angeles plant of National Container Corp. The plant now contains 150,000 sq. ft. under one roof.

Hercules

At Hopewell, Va., Hercules Powder Co. recently erected an entirely new plant for the manufacture of a cellulose material made from cotton linters.

The linters come to the Hercules plant in 600-lb. bales—measuring approximately 24 by 46 by 55 in. when shipped locally or, when shipped by water, compressed to 24 by 24 by 55 in. in size, which makes them much harder.

Part of the purpose of the new plant was making the manufacture of the cellulose material a continuous process, so timed as to balance the rate of feed of the linters with the chemicals to be mixed with them in the digesters.

Taylor, Stiles & Co. of Riegelsville, N. J., were asked to develop a bale-breaking machine, along the lines of others built by this concern to break bales of straw in papermaking.

This was done and bale breakers were designed in cooperation with Hercules engineers. The bales are opened and the material loosened up thoroughly, then conveyed by air through long pipes to the digesters. Chemicals are likewise piped to the digesters. After processing, the materials pass to washers and bleachers and then again are piped several hundred feet to another building for drying.

St. Helens

The contract for constructing number 3 paper machine room at St. Helens Pulp & Paper Co., St. Helens, Ore., has been awarded to L. H. Hoffman, Portland contractor. The two-story building will be located between the office building and the present machine room housing numbers 1 and 2 paper machines.

Planned by CZ's Central Engineering department at Seattle, the machine room is said to be the most modern in the paper business and is designed to house what company officials understand to be the largest Yankee tissue machine ever built. It is expected the building will be ready for occupancy late in 1954. The building will be of reinforced concrete and structural steel. It will be 90 ft. wide, 300 ft. long, and 60 ft. high. Exterior walls will be precast concrete panels bolted to steel frames. Modern lighting, heating, and ventilating systems and a modern tile and concrete locker room with shower baths and wash fountains will be installed. A 30-ton over-

head crane will be installed to travel the full length of the machine.

The paper machine, now being built by the Beloit Iron Works at Beloit, Wis., will turn out tissue grades in substantial quantity as it has a 258-in. wire.

Hartford City

The Hartford City Paper Co., Hartford City, Ind., has elected two vice-presidents. Olof H. Hedstrom was elected vice-president and general manager, and C. L. "Cliff" Kraning was elected vice-president and sales manager.

Marathon

A $50,000 project to reduce sulphite pollution of the Wisconsin River is nearing completion at Marathon Corp., Rothschild, Wis. A 6-in. pipe line, 3000 ft. long, is being laid across the river on the mill's dam, pumps are being installed, and a soil-filtration pond is being prepared to receive 100,000 gallons per day of effluent from the sulphite mill and chemical plant.

Permacel

A new water-resistant, high-strength sealing tape for cartons, paper tube ends, and bundles is being made by the Permacel Tape Corp., New Brunswick, N. J.

Paper-backed and specially impregnated with a waterproof rubber resin composition, the new tape, known as P 17, is designed to withstand extremely rough handling in shipment under both dry and wet conditions.

Scott

Another vital link in the chain of Scott Paper Co.'s production operations has been added with the addition of the new Everett, Wash., paper mill.

Combined with the splendid sulphite pulp facilities of the former Soundview Pulp Co. which was a leading industry on the Pacific Coast for many years, and with the two pulp mills of Scott's wholly owned subsidiary, Coos Bay Pulp Corp., with plants at Anacortes, Wash., and Empire, Ore., Scott now has a coast-to-coast network of pulp and paper mills.

Other plants behind Scott's products are at the following locations: Chester, Pa.; Hoboken, N. J.; Fort Edward, N. Y.; South Glens Falls, N. Y.; Sandusky, Ohio; Marinette, Wis.; Oconto Falls, Wis. Scott Paper Co. and the Mead Corp. operate jointly the Brunswick Pulp & Paper Co., Brunswick, Ga.

The story of Scott Paper Co. began in 1879, when two brothers, E. Irvin and Clarence Scott, started a business in Philadelphia.

Many of the conveniences and comforts of modern life are relatively new, as time is measured. Our forefathers made their own tallow candles and their own soap. Candles were gradually replaced by improved methods of lighting and commercially manufactured soap was in use by 1879. Sanitary plumbing also came into use in this country later in the nineteenth century. These and other developments came to change the habits of people and to lay the foundations for more convenient and more hygienic standards of living.

Stimulated by such developments and influenced by the introduction of sanitary plumbing, the Scott brothers saw an opportunity for the promotion of toilet tissue.

Several paper mills were selected on a contract basis to manufacture large "parent rolls" of paper. The Scott organization converted this paper into smaller rolls of toilet tissue.

In 1896, Irving Scott's son, Arthur, joined the business, bringing with him an idea which was to affect dramatically the future of the company. He recommended the discontinuance of the multitude of brands being produced, feeling that concentration on a limited number of products of high quality and value would command increasing public favor.

By 1910 Scott Paper Co. had gained a clear sense of direction from Arthur Hoyt Scott's three simple fundamentals of business: (1) to make a few limited number of products of the consumer's choice and of the highest possible quality; (2) to make them at the lowest possible cost and to give the consumer the greatest possible value; (3) to tell the public about them through advertising.

T. B. McCabe, Scott Paper Co.

R. C. Mateer, Scott Paper Co.

The wisdom of this program became evident within a short time. By 1911 the company's own trade-marked products accounted for almost 80% of its sales. Two years later Scott Paper Co. celebrated its first million dollar sales year.

As time went on it became increasingly evident that better controls of quality were necessary if the business was to continue to grow. In 1908, Harry Liebeck, the plant superintendent, urged that the company manufacture its own tissue, thus controlling its quality characteristics.

It was a bold suggestion. Such a plant would cost $100,000. In 1908 the company's total business amounted to only $135,000. Two years later, however, a building formerly used as a soap factory, located on the Delaware River in Chester, Pa., was purchased. By December of that year two paper machines had been installed. At the present time the Chester plant, which is also the home office of the company, houses ten paper machines.

In April, 1917, America went to war. Soldiers on the Western Front were met by a diabolical combination of chemical smoke and poison gas. Masks would afford protection from gas but failed to exclude smoke which would penetrate, choke the wearer, force him to remove the mask, and expose him to the gas.

The Government set out to find a material which would filter smoke. A porous, laminated paper called "Zorbik" was developed and manufactured by Scott. It was used in the canisters of new gas masks sent to France, saving many from the horrors of smoke and poison fumes from gas.

Scott Paper Co. Board of Directors: Left to right around the table: J. Larcom Ober, Charles R. Van de Carr, Jr., Thomas S. Gates, Jr., Roswell H. Rausch, Walter A. Starr, William Clarke Mason, Raymond C. Mateer, Thomas B. McCabe, U. M. Dickey, Stanley Resor, Francis W. Plowman, G. Willing Pepper, William M. Carney, William R. Scott, 3rd

U. M. Dickey, Scott Paper Co.

P. C. Baldwin, Scott Paper Co.

The war brought other problems, too. The price of wood pulp advanced rapidly and more than doubled the cost of Scott products. Prices could have been kept lower by using cheaper grades of pulp, but that would have been an unacceptable compromise with quality. Despite such difficulties the company weathered the wartime period surprisingly well. It was an interval of meager earnings, but dollar volume for 1917 and 1918 surpassed any previous record.

Scott sales in 1920 equaled almost two and three quarter million dollars. Arthur Scott was named president that same year, and Thomas B. McCabe became sales manager.

As the growth of sales activities continued, steps were taken toward the creation of definite distribution territories. In 1926 selling operations were divided between a retail department, responsible for the sale of products used in the home, and an industrial department for sale of products used away from home. The company's present-day distribution program continues to follow this original pattern.

Following Arthur Scott's death in 1927, Thomas B. McCabe was elected president of the company. Under his leadership the business grew rapidly, assuming the proportions of the present time.

The company first entered the pulp manufacturing field in 1927 when it acquired the outstanding capital stock of Nova Scotia Wood Pulp & Paper Co., Ltd., which owned a pulp mill and woodlands in Charlestown, N. S. This mill burned to the ground in 1947 and was never rebuilt.

Near the end of 1936, Scott Paper Co. and The Mead Corp., Chillicothe, Ohio, organized Brunswick Pulp & Paper Co., which constructed a pulp mill to produce bleached sulphate pulp near Brunswick, Ga. Operations began early in 1938. One half of the capital stock of the Brunswick Co. is owned by Scott and one half by Mead.

In 1940, the company purchased the entire outstanding capital stock of Coos Bay Pulp Corp., Empire, Ore., and also organized Anacortes Pulp Co. which acquired a plant at Anacortes, Wash. The latter subsidiary was subsequently merged into Coos Bay Pulp Corp. Both of these plants produce unbleached sulphite pulp.

During World War II, Scott Paper Co. was again privileged to render service to the Nation by manufacturing Government specification toilet tissue. This tissue was called ration "K." The company also produced a special lens tissue used to clean precision instruments. Scott plants also produced pulp for munitions, lend-lease, and other war uses.

In 1941 Scott Paper Co.'s newly formed subsidiary, Marinette Paper Co., purchased plants and equipment at Marinette, Wis., and South Glens Falls, N. Y. The Marinette, Wis., plant manufactures a substantial portion of its requirements of bleached sulphite and groundwood pulps. Late in 1944 Marinette purchased a third paper mill property at Fort Edward, N. Y.

Through Delaware Pulp Co., another subsidiary organized in 1942, Scott owns equipment in Clermont, Quebec, for the production of groundwood pulp. The equipment is operated under agreement by Nairn Falls Pulp Co., Ltd., with Delaware.

Early in 1945 Scott Paper Co. acquired the assets of the Automatic Paper Machinery Co., Inc., manufacturers of "Cut-Rite," the leading brand of household wax paper in America. Papermaking equipment at Milford, N. J., and converting facilities at Hoboken, N. J., and Sandusky, Ohio, were included in these assets.

In February, 1951, the company acquired additional pulp and papermaking facilties through the purchase of Falls Paper & Power Co. located at Oconto Falls, Wis.

One of the most significant steps in Scott history was taken in November, 1951, when stockholders of Scott Paper Co. and Soundview Pulp Co., Everett, Wash., agreed to a merger that brought into a single enterprise all the assets of both companies. For years, Scott had been searching for a favorable site on the West Coast for construction of a modern paper mill. The merger provided the ideal site adjacent to Soundview's sulphite pulp mill, and in 1952 construction was begun of the new paper mill, converting plant, and innumerable necessary supporting facilities.

Great savings are anticipated from the operation of the combined pulp and paper mill, where wood pulp is piped in slush form directly to the paper machines, thus eliminating the cost of drying and baling the pulp for shipment over a greater distance. Equally as important savings should result from having such an operation located near the very substantial and continually growing markets of the West Coast.

In addition to the plant assets at Everett, the merger made available to Scott extensive timber tracts in the Pacific Northwest. Soundview also contributed highly competent management and technicians of demonstrated ability.

The new paper mill at Everett brings to the Pacific Northwest one of the most modern and efficient paper mills in the world.

Presently operating in this building is one high-speed paper machine complete with all auxiliary equipment for manufacturing paper and for making finished products. A second machine, currently under construction, will be ready for operation this year.

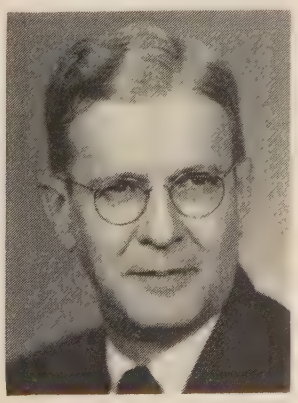
The new machine is making paper for the company's three nationally known brands of toilet tissue: "Soft-Weve," "ScotTissue," and "Waldorf." These brands will be distributed in Scott's western sales territories.

The second machine will make paper for other Scott brands, also to be distributed in western markets.

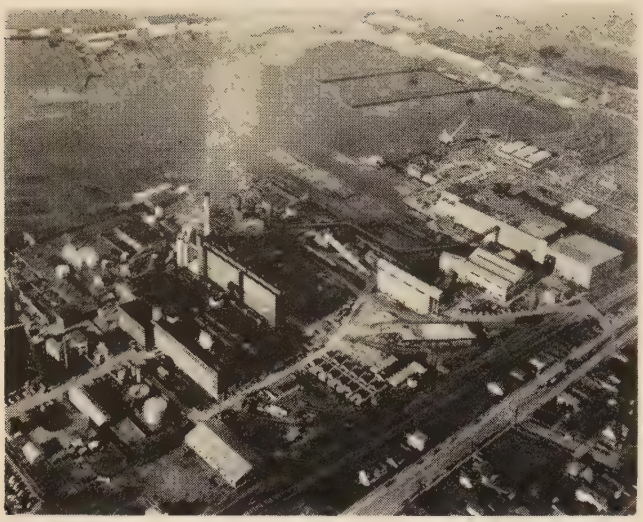
The streamlined paper mill building is much more than a mere structure to house the machines and converting equipment required to transform the large parent rolls of paper into consumer-sized units of Scott products.

Complete with harmonious color effects and recessed lighting in the high ceilings and adjacent areas, the mill is equipped

L. S. Burdon, Scott Paper Co.



N. W. Coster, Scott Paper Co.

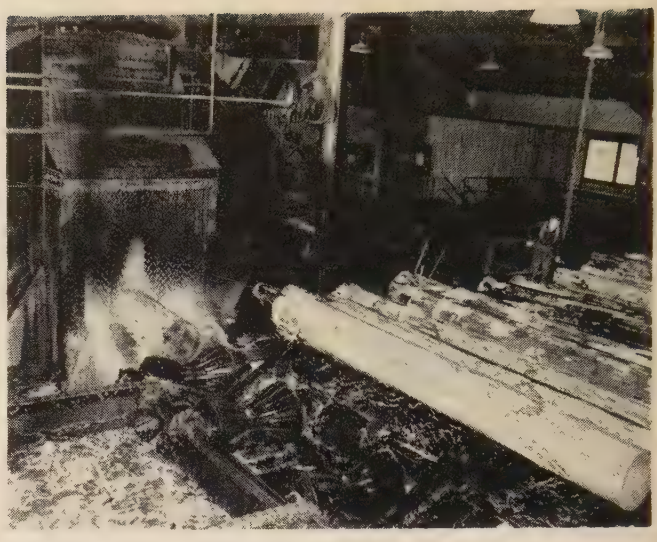


Scott Paper Co.'s pulp and paper mill, located on Puget Sound at Everett, Wash., is pictured above. The new paper mill, shown at the right, currently houses one high speed paper machine which went into production in December, 1953. Plans are under way for the construction of a second machine which, when completed, will bring production of the Scott line to the West Coast for the first time. The giant pulp mill, which was owned and operated by the Soundview Pulp Co. prior to the merger of the Scott and Soundview companies in November, 1951, produces high quality bleached sulphite pulp which is piped directly to the paper machine for manufacture of Scott's household products

with comfortable lounges, rest rooms, locker room, and shower facilities for men and women. Ample space is also provided for offices and storage areas.

The shipment of finished goods is expedited through conveyor systems which take cases directly to freight cars brought into the building. Car wells are under cover to make possible continuous loading of cases that will roll daily from this plant.

Timber operations—Vast stands of timber form picturesque background as truck, loaded with logs, follows winding road to the reloading area



Pulp operations—Tremendous water pressure removes bark from logs hydraulically. Frank Marlin inspects logs following removal of bark

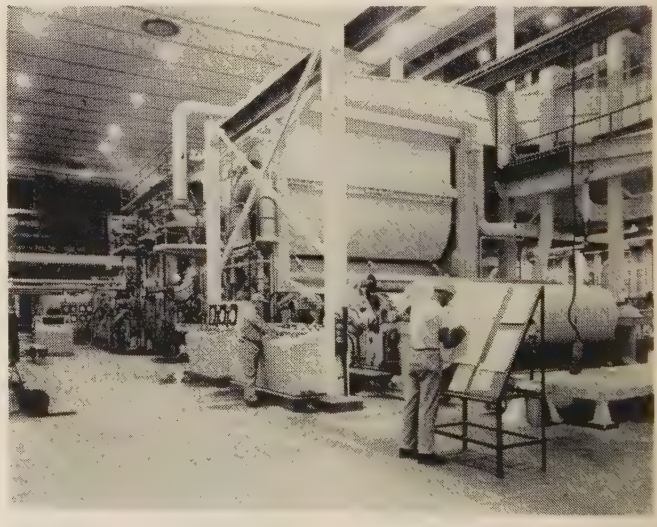
The story behind the company's new paper mill goes back to the date of Scott Paper Co.'s merger with Soundview Pulp Co. in November, 1951.

At that time, Scott President Thomas B. McCabe, stated that bringing together the assets of these two great companies would be one of the most significant steps in their histories, and would add materially to the sound foundation for future growth and development. The Scott-Soundview merger was the largest transaction ever made by Scott Paper Co.

Soundview Pulp Co. was organized in 1932 under the laws of the State of Washington to operate a newly constructed pulp mill at Everett, Wash. At the time of the merger, Soundview was operating a modern, efficient 600 ton-per-day bleached sulphite pulp mill employing some 550 persons, exclusive of approximately 1000 persons employed seasonally in logging operations.

At present, plans are under way to increase the mill's capacity by approximately 120 tons of pulp a day.

Also, at the time of the merger Scott acquired cutting contracts and investment in the capital stock of various logging companies owning timberlands and cutting rights both in Washington and British Columbia, with an estimated yield in excess of three and one half billion board feet. Also involved were over 100,000 acres of logged-off land upon which



Paper Operations—Dick Graham, Howard Nichols and Jack Bauer are pictured during operation of the new, high-speed paper machine which went into production in December, 1953. Scott Paper Co., Everett, Wash.

second-growth timber is expected to mature to provide a future supply of raw material.

Western Washington has been called the "most beautiful part of America." Bounded on the East by the Cascade range of mountains, the area extends to Puget Sound, the huge, sheltered arm of the Pacific Ocean.

The City of Everett is located in the heart of the Puget Sound section of Western Washington. It is a highly desirable site for business, recreation, and comfortable living.

Well suitated for water or rail transportation, Everett is accessible in many ways. For the pulp and paper industry, the location is ideal. Water is available in great quantities and logs are delivered at mills directly from woods operations situated not far from the city limits.

To insure an adequate supply of raw material, Soundview in 1937, began to acquire timberlands and since that date, through outright purchase, cutting contracts and investment in the capital stock of various logging companies owning timberlands and cutting rights in the state of Washington and in British Columbia, the company acquired timber resources estimated to yield in excess of three and one-half billion board feet.

Operations commence in the woods where logging is conducted in King, Snohomish, Skagit, and Whatcom counties, Wash. Some of the logging companies in which Soundview held financial interests were located in British Columbia; others in western Washington.

One of the greatest steps made by Soundview in the matter of timber conservation was taken in 1945 with the installation of equipment for removing the bark from pulpwood logs by hydraulic pressure. This system replaced the conventional method of removing bark preparatory to chipping thus permitting the utilization of nearly 20% more wood fiber which formerly was removed along with the bark and could be used only as fuel.

Soundview was among the first companies in the industry to employ the full-scale chemi-pulp, or hot acid process, and the SO_2 recovery process in the manufacture of pulp.

Ecusta

The Ecusta Paper plants stand beside the old Estatoe Trail—route of the Cherokees.

While traveling this long and mountainous trail between their Winter camp grounds in Georgia and Summer camps in the Carolinas and Virginia, they always rested on the banks of the Davidson River. The Indians called the stream "Ecusta," which in their language meant "rippling waters." The stream and the "stopping-over" place was known as Ecusta until 1790, when Benjamin Davidson changed the name to Davidson River after he had received a grant of 640 acres in this area.

The Davidson River is the source of all water that we use. The stream drains an area of 40.4 square miles of uninhabited forest land, lying wholly within the boundaries of Pisgah National Forest. It is interesting to note that every inch of rainfall over the water shed is equivalent to 700 million gallons of water.

By virtue of the mountainous terrain in which it rises and flows, the Davidson is a flashy stream. Its rate of flow, therefore, varies considerably throughout the year and in direct relation to the amount and intensity of the rainfall.

The rainfall in this area is high, averaging close to 63 in. per year with a maximum on record of 82.76 in. and a minimum of 44.34 in. for the past 20 years. As much as 17.77 in. has fallen in one month; 8.51 in., in a day; 2.64 in., in an hour.

As a result of such variations, the discharge of the Davidson has varied from as high as 1600 million gallons a day to as low as 18 million within the same year, as compared with the 32-year daily average of 83.5 million gallons.

Water from the Davidson is what is technically known as surface supply and as such picks up color, turbidity and tastes, the degree of which varies with the rainfall. During the dry periods, however, the stream is fed entirely from springs which serve as outlets for the natural underground water storage created by that part of the rainfall which seeps into and through the soil. That this underground supply is of considerable magnitude is evidenced by the substantial flow of the river during protracted periods of little or no rainfall.

The geological formation of our mountains is such that water passing through it does not materially change in chemical make-up and the absence of all limestone precludes any appreciable increase in hardness. Thus, the water we obtain is normally low in hardness, iron and manganese content, salt, and bacteria.

Since cigarette paper ultimately reaches the lips of smokers and cellophane is used for the wrapping and packaging of food products, they must be manufactured under the most sanitary conditions possible. Therefore, every drop of water used must meet the highest standards for human consumption as well as the exacting requirements for process.

This is accomplished in our eleven-bed filter plant, one of the largest in the South, having a normal rated capacity of 20 million gallons per day with a possible maximum of 25 million. To date, the maximum filtered in one day has been 23 million gallons.

Water from Davidson River is pumped to the filter plant by five large centrifugal pumps in the river pump house. As raw water enters the filtration plant, alum and hydrated lime are added for flocculation, and anhydrous ammonia and chlorine for sterilization. These chemicals are added directly into the incoming pipe line, and in amounts determined by jar tests made on the river water. All chemicals combined amount to around 500 tons per year, which gives an idea of the magnitude of the operation involved.

After the chemicals have been added, the treated water passes through the mixing basins where it is mixed thoroughly by flowing up and down through a series of horizontal baffles. This mixing aids and hastens the chemical reaction to form the floc. By the time the water reaches the end of the mixing basins, which takes approximately 30 minutes, the floc is usually well formed and is ready to proceed to the coagulation or settling basins.

These basins are used to pemit sedimentation of the coagulated water, and to enable the coagulation process to be completed in case this has not been accomplished thoroughly in the mixing basins. At the end of the settling basins the top layer of the water is skimmed off, and then allowed to flow into the filter beds.

In the filtering operation the water passes through the sand and gravel beds from top to bottom by gravity. Normal filtration rate per bed is 1250 gallons each minute or 1,800,000 gallons a day.

As the water passes through the bed, a mat is formed on the top of the sand, frequently referred to as a "schmutz decke" which is the German expression for "dirt cover." This mat serves as the main filtering agent of the bed and prevents deep penetration of the sand by the floc. As the filtration process continues, this mat increases in thickness, which in turn increases the resistance to the flow of water through the bed. When this resistance, which is technically called loss of head, reaches 7 ft., the bed must be washed to restore its effectiveness. The frequency of wash depends upon the quality of water entering the bed and may vary anywhere from 20 to 230 hours.

The effluent from the filter beds, which is referred to as filtered water, is free of all impurities and bacteria. It has no color or taste.

The filtered water flows into underground collection basins or clear wells, where it is treated to meet process specifications. From there it is pumped into reservoirs and then to the mill.

A fully equipped laboratory is provided at the filter plant where all control and analytical tests including bacteriological

examinations are made. Tests are made regularly on water in all stages of purification and on boiler feedwater, steam, and return condensation. Unrelated to water but of major importance are the quality control tests made here for ash, moisture, and heat content of the coal used in the boiler. Around 250 tests of all kinds are made each 24 hours.

To facilitate the over-all operation, a central control board is located in the filter plant from which all pumps can be operated either manually or automatically. Mounted on the board are numerous indicators and recorders which keep operators posted on conditions throughout the entire system. Connected with the various instruments is an alarm system which rings a bell when other than normal conditions exist.

The water sampling table in the laboratory has observation cylinders and outlets to permit viewing and sampling the water at its various stages of purification.

A U. S. Weather Station is maintained at the filter plant by the operating personnel. A daily record is kept of the temperature, relative humidity, precipitation, character of day, fog, hail, thunderstorms, etc. From these and by information from the weather bureau in Asheville, extreme weather conditions are anticipated which greatly aids in the operation of the plant.

A gaging station, to record the flow of Davidson River, is maintained by the U. S. Geological Survey on Ecusta property at a point where the stream emerges from Pisgah National Forest. Daily recordings from this gage serve as additional operational aid.

—from *The Echo*, June, 1954, Ecusta Paper Corp., Pisgah Forest, N. C.

St. Regis

St. Regis Paper Co., New York, and North Canadian Oils, Ltd., Calgary, Alta., have under active negotiation plans for the financing and construction of a 300-ton mill for the production of bleached sulphate kraft pulp at Edson, Alta.

Under the terms of the plan St. Regis and North Canadian's subsidiary, North Western Pulp and Power Co., will each provide $5 million of the proposed $10 million equity capital, while $20 million senior financing is to be raised from other sources. This $30 million will cover cost of building the mill plus working capital.

An engineer's report, it is indicated, reveals basic costs at a level well able to meet those of competing mills, and a perpetual timber supply. Requirements for 65 years are now available without allowing for regrowth. North Western Pulp holds an agreement with the Alberta government for long-term cutting rights on an area over 4000 square miles in that province.

It is indicated that under the plan under consideration, St. Regis will take a substantial part of the mill's output and will sell the balance through its sales organization. The growth trend in industry and in population and the marked expansion currently under way in the utilization of bleached kraft pulp provide a constructive background for the marketing of the output of the projected mill.

During the past 10 years the production of bleached and semibleached sulphate pulp in the United States has risen over 330%, while imports of this grade of pulp into the United States rose 1350% during that period.

Tribune

Col. McCormick, president of the Tribune Co., which owns the Chicago *Tribune*, the New York *News*, The Ontario Paper Co., Quebec North Shore Paper Co., and eleven other subsidiaries in the United States and Canada, reported to the stockholders recently that the combined gross sales of the companies in 1953 totaled almost $250,000,000. Despite rising expenses that made economies mandatory through increased production and improved efficiency in all operations, the Colonel said the outlook for the Tribune Co., and its subsidiaries in 1954 was good.

New Records Achieved

New records were achieved in the field of newspaper publishing and in providing advertising service beyond anything achieved in the past. "Advertisers," he stated, "spent in the two newspapers—the Chicago *Tribune* and the New York *News*—more than $100,000,000 in 1953, setting a new sales peak for each paper. The papers were first and second in the United States in advertising revenue."

"The New York *News*' circulation is more than twice that of any other newspaper in the country and the Chicago *Tribune* circulation is the largest of any standard size newspaper.

"The combined sales volume in 1953 of the radio and TV stations—WGN, WGN-TV, and WPIX—owned by the corporation in Chicago and New York, was the largest in their history."

Progress in Canada

Col. McCormick cited other 1953 records. The Ontario Paper Co. and the Quebec North Shore Paper Co. produced 365,000 tons of paper, which supplied the *Tribune* and the New York *News* with approximately 80% of their paper requirements.

The Canadian companies also produced more than 400,000 peeled cords of pulpwood. New world's records for speed were set on the papermaking machines at the Baie Comeau, Que., paper mills last March.

The chemical developments of the Canadian companies also reached a new high in 1953 for the production of alcohol, vanillin, lioxin, and other products from waste materials. Further expansion during the year also took place in the electric power developed at the Manicouagan Power Co.'s McCormick dam, near Baie Comeau.

Spending to Improve Efficiency

Since the end of World War II, the companies invested millions of dollars of additional capital in plant expansion throughout the entire organization to improve efficiency of operations and to add new products in the Canadian plants. This will not only provide additional employment, but also will produce additional wealth from pulpwood wastes, thus increasing the utilization of our forest products.

Among the new investments listed as having been made to improve efficiency since 1945 were the following: new presses for the *Tribune* and the New York *News;* a new WGN building; television facilities for WGN-TV in Chicago and WPIX in New York; a new 40,000-ton newsprint terminal and warehouse for the New York *News;* the McCormick dam in Quebec; five new ships for the Quebec and Ontario Transportation Company's fleet, bringing the total ships to 11, and expansion of papermaking facilities in Canada.

Costs Increase Faster than Sales

Publishing costs increased during the year to a greater degree than the sales income of the companies, and have continued to rise so far in 1954. The Colonel stated wages and salaries paid by the Tribune companies increased 166% from 1945 to 1953, and the costs of paper, pulpwood, and other materials and supplies have increased proportionately.

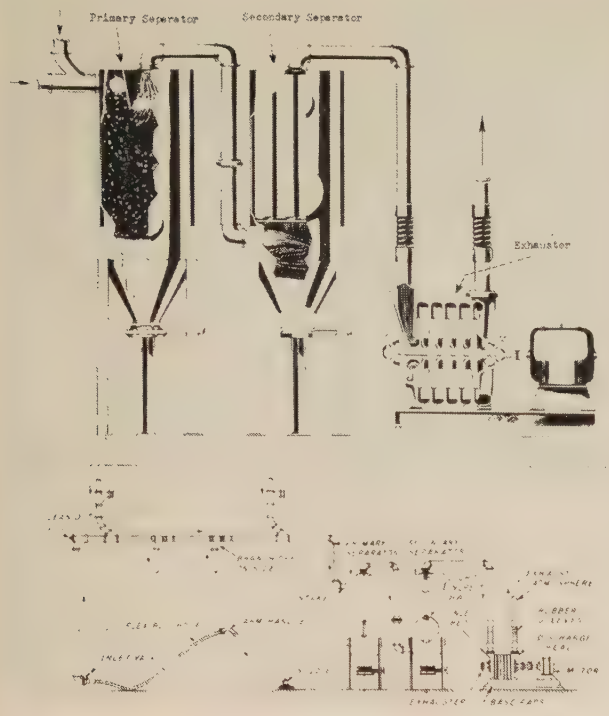
Buckeye

Buckeye Cellulose Corp., a Procter and Gamble subsidiary, recently started up its new pulp mill at Foley, Fla. The plant covers 54 acres and is adjacent to its wood source, a 570,000-acre tree farm, also owned by Buckeye.

The 300-ton mill will double Buckeye's production of dissolving pulp, and will employ 350 production workers plus 150 other employees.

Clifton

By using an industrial version of a device familiar to every housewife—a vacuum cleaning system—power plant engineers



Schematic drawings of central vacuum system showing, above, details of the primary and secondary separators and exhauster, and, below, the layout of an entire system

at Clifton Paperboard Co., Clifton, N. J., have cut hours each week from the usually laborious and time-consuming job of recovering unused coal from their boilers. The same central vacuum system does double duty by cleaning fly ash from the boilers—and in less than half the time formerly needed.

The plant operates four large Harrington Stoker boilers (total 3300 hp.) to produce the steam used in the manufacture of paperboard and other paper products. The boilers are fired with rice and barley coal which is fed from hoppers on to chain grate stokers. During the course of a week, 2 to 3 tons of fine coal slip through the 21-ft.-wide chain grates and collect in the wind box. About once a week the coal is recovered from the wind box; ashes from the fire bed fall into another section of the boiler.

Formerly, the coal was recovered by using a long handled hoe to scrape the coal from the wind box out on to the boiler room floor. Because of the 4 to 9-ft. clearance between the boiler housing and the building wall, the 16-ft. hoe handle was constructed in several sections connected by threaded joints. This meant that each time the hoe was pulled out of the wind box, the handle had to be partially dismantled, and then reassembled to reach into the boiler again. The recovered coal would be shoveled into a wheelbarrow and taken, one load at a time, to the coal yard where it would eventually be shoveled into a coal elevator for return to the hoppers. As a result, 6 men spent nearly a full day each week to remove the coal from the 31 wind boxes and return it to the feed hoppers.

Several years ago, Clifton Paperboard installed in its boiler room a Lamson Billmyre central vacuum cleaning unit to take over the job of coal recovery. Now the process not only is cleaner and more convenient, but also saves time in amounts well worth reckoning. The job that once took 48 man-hours is now accomplished by three men in 5 to 6 hours, a labor saving of better than 60%.

Here's how the system works. A vacuum (9 in. mercury) is created by a 790-c.f.m. Lamson Billmyre blower, and is carried in a 5-in. diameter pipe to various locations in the boiler room. Hinged caps in the pipe enable workers to connect a flexible-hose-and-nozzle assembly into the vacuum virtually anywhere in the boiler room. As shown in the accompanying illustration, a pair of hoppers is installed on the vacuum side of the exhauster. The first hopper is the primary separator where the larger particles are separated out. The secondary separator traps the fine particles and dust.

To clean out a wind box, boiler room personnel connect the flexible hose to the nearest vacuum outlet and insert the metal nozzle into the box (see photo). The coal is picked up by the vacuum and carried back through the system where it is collected in the primary separator of about 3-ton capacity.

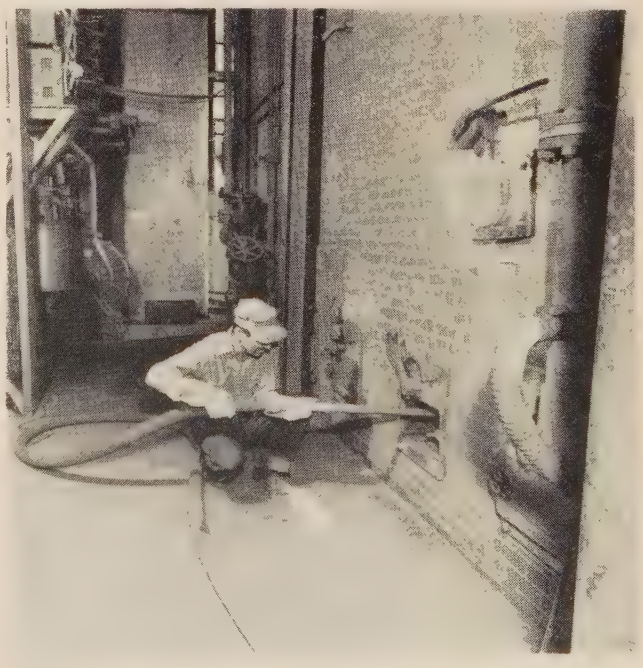
The recovered coal is dropped through a hatchway at the bottom of the separator into a large, wheeled lorry which takes the coal back to the furnace's coal hopper for reuse. The fine particles and dust are reclaimed by a vacuum driven fly-ash reclaimer connected to the top of the secondary separator. The reclaimed fines are blown directly into the fire bed for their fuel value.

The central vacuum system is versatile. It is also used to clean out collected fly ash from the boilers during routine maintenance shutdowns, usually once or twice a year. The vacuum system saves a considerable amount of time in this operation too. Formerly, the fly ash was removed by a team of three men per boiler. One man working in the boiler would shovel the ash into a bucket, the second would carry it to the boiler door, and the third man would empty the ash into a wheelbarrow for disposal.

Now, one man using the vacuum-connected hose can clean out a boiler by himself. Actually, three or four men work simultaneously in individual boilers, each with a separate hose line, and remove the fly ash in less than half the time required by the old shovel-and-bucket system.

In addition to these two major uses of the vacuum system, the system is also used for routine clean-up of dirt and soot around the boiler room, on floors, walls, beams etc., with far less dust and in considerably less time than with the usual broom-and-shovel technique.

Speaking only of the time and manpower saved in performing these once grimy, but necessary, boiler room chores, Joseph K. Kroboth, chief engineer at Clifton Paperboard, estimates



With the central vacuum system, coal is recovered from the 21-ft. wind boxes quickly and cleanly in about one third the time required with the old hoe-and-wheelbarrow method. The same system is also used for cleaning out fly ash from the boilers and for general boiler room maintenance. Lamson Billmyre exhauster that produces the vacuum is located in the corner at far left; one of the hose connections to vacuum manifold is at right foreground

that the system paid for itself fully after 2 years of operation. From the standpoint of convenience, cleanliness, and higher morale—all intangibles, but all important to the operating efficiency of any power plant, the system continues to pay additional dividends every week.

Rayonier

To be known as the Jesup Division the new chemical cellulose plant of Rayonier Inc. is located on a 538-acre site on the Altamaha River, $4^1/_2$ miles north of Jesup, Ga., on U. S. highway 301. The 90-acre mill area is enclosed by a Cyclone fence supplied by U. S. Steel & Wire Co. Over 5 miles of railroad spurs on the mill site connect with the Atlantic Coastline Railroad and with the Southern Railway.

The new plant will consume approximately 200,000 cords of wood per year which will principally come from tree farms in Wayne and adjoining counties. Incoming wood arrives by both truck and rail facilities. Two cranes, a 40-ton American Locomotive diesel-electric and a $1^3/_4$-yd. P&H diesel crawler, unload the incoming wood with Blaw-Knox pulpwood grapples. Pulpwood can be placed either into storage piles or directly into the flume for immediate use. Wood storage facilities are designed for a maximum inventory of 20,000 cords.

A Rayonier designed truck unloader is an interesting feature of the new mill. This new installation permits trucks to back up to the flume and the wood is rapidly unloaded directly into the raceway leading to the barkers. The advantage of this new equipment is that it permits very rapid handling of wood trucks.

A concrete flume more than 1000 ft. long carries wood from the storage area to the barking plant. Water for the flume is circulated by two 16,000 g.p.m. Bingham pumps, each of which is equipped with 100-hp. Westinghouse motors.

The pumps maintain a rapid flow of water in the flume so that fresh wood which has a tendency to sink moves quickly to the barkers.

The flume system is equipped with a Link-Belt water screen and flume cleaning system, which removes all bark from the flume for burning in the bark boiler. Sand is removed by separate equipment and hauled away by trucks using the Dempsey Dumpster system.

Wood coming down the flume can be routed either to the two barking drums or the hydraulic barker. A continuous Hansel 18-in. hydraulic barker requires 1200 g.p.m. of water at 1550 p.s.i.

William E. Breitenbach, Rayonier vice-president in charge of production, accepts the symbolic key for the new $25 million chemical cellulose plant from Russell F. Erickson, vice president in charge of engineering, who built the plant. The key, significantly, was made from southern pine—the basic raw material for Rayonier's newest type of high quality chemical cellulose

Clyde B. Morgan, president of Rayonier Inc., seen on the speakers' platform during ceremonies inaugurating the company's 5th chemical cellulose plant. Mr. Morgan is wearing a souvenir tie embroidered with Rayonier's new emblem

The two barking drums are 12 ft. diam. by $67^1/_2$ ft., and each drum consists of three sections each of which is driven by a 75 hp. motor.

Wood from both the hydraulic barker and the two barking drums is inspected on a 72-in. wide rubber sorting belt 120 ft. long. Reject wood is recycled to the barking drums, and clean wood is conveyed to the chipping plant. Large diameter logs go to a D. J. Murray special stationary ax-type splitter which will handle pulpwood up to 36 in. in diameter, reducing it to required size for the chippers.

Chipping is accomplished by two 110-in., 10-knife D. J. Murray chippers, each of which is driven by a 1000-hp. synchronous motor designed for 250% pullout torque.

The chip screening equipment consists of three Allis-Chalmers 5 by 16-ft. low head chip screens. Rejects from the chip screens are conveyed to a D. J. Murray rechipper and then rescreened. All accepted chips are conveyed by belt conveyors to the chip storage bins.

Chip storage facilities consist of six Semtile circular storage bins 30 diam. by 80 ft., constructed by Stebbins Engineering Co.

Jeffrey vibrating feeders remove chips from the bins for their delivery over Merrick weightometers to the digesters.

All of the basic conveyor systems for the handling of wood and chips were supplied and erected by the Jeffrey Manufacturing Co.

An interesting feature of the new Jesup mill is the use of a TV camera at the top of the chip storage bins to permit the operator at ground level to view the contents of each bin, so that he can control the shuttle belt which delivers chips into each of the six bins. The TV camera and receiver were built by Diamond Power Specialty Co. and installed by Graybar Electric Co. technicians. This facility will save the operator many trips to the top of the 80-ft. high bins.

Complete flexibility has been designed into the chip handling and storage facilities to permit complete separation of the various wood species. It also allows chip to be blended in any proportion for loading digesters.

The digester house contains 8–12-ft. diam. by 55-ft. stainless steel lined digesters, six of which were fabricated by the A. O. Smith Corp. and two by Chicago Bridge and Iron Co. The digester circulating systems and special stainless steel valves were supplied by Esco of Portland, Ore.

Cooking liquor is made up in the liquor recovery system located east of the digester building. Black liquor from the three Impco 9-ft. 6-in. by 16-in. brown stock washers goes to the recovery system through a Waco filter also supplied by

Debarked clean, southern pine comes hurtling from a barker on its way to a chipper at Raynonier's new chemical cellulose plant at Jesup, Ga.

Impco. From large black liquor storage tanks the liquor then flows into sextuple effect evaporators, supplied by General American Transportation Corp., where it is concentrated to 50% total solids. This passes through two wet bottom type Cottrell precipitators designed by Research Corp. Each precipitator is designed for a capacity of 110,000 cu. ft. of gases per minute. The primary purpose of these precipitators is the reclamation of valuable process chemicals from flue gases, but approximately 20% excess capacity was provided to eliminate the carryover of solid particles into the atmosphere. This "overdesign" was intentional. Air pollution and odor problems are thus minimized.

It is a well-known fact that the odor-producing compounds tend to cling to the surface of dust particles which, if not eliminated, will contribute odors. By eliminating the very fine dust particles the volume of odor-producing components is minimized and odors emanating from the mill are substantially reduced.

All the gases from the recovery boilers, after coming through the precipitators, are discharged into a 16 by 250-ft. concrete stack erected by the M. W. Kellogg Co. The stack is lined with acid-resistant brick laid in special acid-resistant mortar. The high stack was selected after careful consideration of prevailing winds and local air currents.

The black liquor, after leaving the Cottrell precipitators, then passes through two cascade evaporators manufactured by D. J. Murray Co. It is then burned in the recovery boilers at approximately 65% total solids. The recovery boilers were built by Combustion Engineering Co. and each is rated at 100,000 lb. of steam per hour. The recovery boilers, bark boiler, and precipitators were erected by the Paul A. Laurance Co. of Minneapolis.

Smelt recovered from the recovery boilers passes to a Dorr Co. recausticizing system. The equipment supplied by Dorr Co. includes a Type A3TB green liquor clarifier 40 ft. in diam. by 24 ft.; Type A3TB 40 by 24-ft. white liquor clarifier; Type ATBHB 35 by 24-ft. 2-stage lime mud washer; and other related equipment such as tanks, pumps, agitators, etc. One unique feature of the causticizing layout was the elevating of the kiln to provide free discharge of reburned lime into the primary slacker. This eliminates the usual troubles of conveying hot fresh lime.

The Oliver Filter Co. provided the 6-ft. diam. by 8-ft. lime mud filter.

The big lime kiln which has a capacity of 100 tons per day is 11 by 10 by 180 ft. and was supplied by Allis-Chalmers. The kiln is equipped with an American Blower Co. Rotoclone which reclaims lime dust and prevents dust contamination in critical operating areas.

Special filtering equipment built by Worthington Corp. will eliminate undissolved solids in the cooking liquor, and a soap skimming arrangement will eliminate excessive scale in the evaporators.

In addition to the two recovery boilers the plant is also equipped with a combination oil and bark boiler with a rated capacity of 135,000 lb. of steam per hour. Built by Babcock & Wilcox this boiler will burn bark and oil simultaneously to provide a wide range of flexibility to meet the steam requirements of the mill.

This boiler is of an unusual design in that it has a traveling grate for ash removal and utilizes a combination of suspension and pile burning for the most efficient burning of the bark. All bark is hogged in two Sumner hogs prior to burning to control particle size.

Heavy no. 6 fuel oil is burned in the boiler as well as in the lime kiln. The oil is received in tank cars and stored in a 10,000-barrel storage tank from which it is transported in steam-heated pipes to secondary, smaller storage tanks located at the lime kiln and at the boiler house.

The pulp is blown from the digesters into a 26-ft. diam. blow tank from which the stock is pumped to the countercurrent brown stock washing system consisting of three 9-ft. 6-in. by 16-ft. Impco washers. All vapors released during the blow period are recovered in a Fibre Making Process Co. blow heat recovery system which provides hot water to the entire mill. High density stock from the final washer passes to a large Semtile storage tank which holds the stock before it moves on the screen.

This tank provides ample reserve capacity to assure operating continuity as well as flexibility for changes in pulp grades. From this tank pulp passes through a special dilution system to six Vibrotor screens supplied by Bird Machine Co. Overflow stock then goes to Impco secondary and tertiary flat

Section of the giant water purification system. Rayonier's Jesup plant consumes some 24,000,000 gal. a day. All water, pumped from four deep wells, has to be scientifically treated for chemical cellulose production which requires highest standards of purity

screens. The screened unbleached pulp next passes through six 12-in. Dirtecs made by Bird Machine Co. The Dirtec units discharge directly into a $9^1/_2$ by 14-ft. Impco tile vat which serves as a rewasher.

Washed pulp from the rewasher then goes through a De Zurick consistency regulator into a 36 by 34-ft. high Semtile pulp blending tank erected by Stebbins Engineering Co. The stock tank serves both for storage and blending. A high rate of blending is obtained with three vertical agitators supplied by the James Brinkley Co. of Seattle. Washed and screened stock is then bleached in a multistage plant designed by Rayonier engineers.

A second high-density storage tank receives the bleached stock. This bleached stock is then diluted with water through a special ratio-control system and pumped to three Bird Vibrotor screens before going into the blending tank ahead of the pulp drying machine.

The pulp machine which was built by Rice Barton Corp. has a number of unusual features. The headbox and slice arrangement uses an entirely new concept to eliminate fiber bundles which result in poor sheet formation. The entire wet end was placed on a mezzanine floor to provide desirable operating features and to eliminate congestion at the operating level. The fourdrinier section is removable to facilitate rapid wire changing, and the entire machine is equipped with antifriction bearings. All metal parts of the wet end are stainless steel clad.

The fourdrinier wire is 175 in. wide by 95 ft. long. Three heavy duty press sections, all hydraulically controlled, were provided with pre-driers inserted between the second and third presses. Auxiliary motors drive the top press rolls. From the third press the sheet drops to the lower building level to enter the stack driers, which consist of 10 stacks arranged for 94—48-in. diam. by 180-in. driers. The machine hood as well as the machine vapor absorption system were designed and furnished by J. O. Ross Engineering Co.

After passing through special sheet cooling units, the dried pulp sheet is wound on a two-drum reel into rolls weighing approximately 12 tons. A special design two-hook crane lifts the roll to an automatic transfer car which transports it to a Toledo scale. After weighing, the roll is placed into either of two roll storage areas, which have a combined capacity of 3000 tons of pulp, where the pulp is held until all chemical and physical tests are completed by the mill technical department. The special roll handling cranes were supplied by the Ederer Co. of Seattle, and all other overhead cranes were built by Northern Engineering Co.

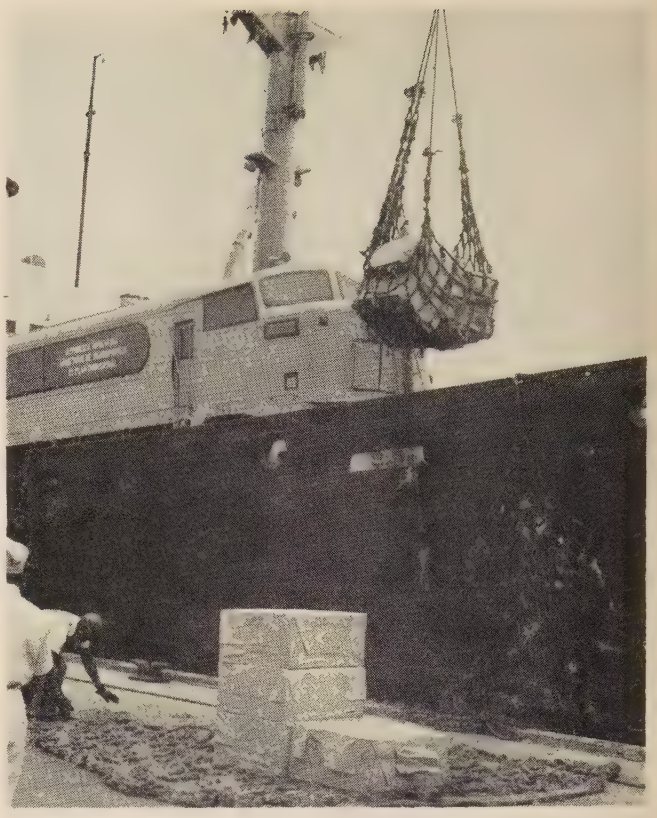
The modern finishing room is located at one end of a building with nearly 5 acres of floor space. This large building houses roll storage, finishing room, and shipping operations, including indoor loading facilities for 12 railroad boxcars.

The pulp cutter and several other pieces of special finishing equipment were supplied by Lamb Grays Harbor Corp. The automatic conveyor system for handling finished bales was designed and built by Matthews Conveyor Co. The two 1000-ton baling presses were supplied by Washington Iron Works.

For roll shipments a separate finishing operation has been installed which includes a rewinder supplied by the Samuel M. Langston Co. with wrapping and handling equipment by Lamb Grays-Harbor Corp. A fleet of Baker electric fork lift trucks, supplied by Baker-Rauline Co. and equipped with Edison C-30 batteries, move the finished rolls and bales into boxcars or storage. Westinghouse Rectox equipment will be used for servicing the Edison batteries.

Water supply for the mill is provided by four 24-in. deep well pumps installed by Layne-Atlantic Co. Each well has a capacity of 6 million gallons per day.

In cooperation with Infilco and Cochrane water specialists, Rayonier designed water treatment facilities which consist of an Infilco accelerator for chemical pretreatment followed by eleven Cochrane automatic water softeners.



First chemical cellulose from Rayonier's new Jesup plant moves to overseas chemical cellulose users. Here the first batch is loaded aboard the SS Rodero bound for Argentina from Savannah's State docks. Accompanying the chemical cellulose is an American-made diesel locomotive for the Argentina Ministry of Transports

The Preload Central Co. constructed the prestressed gunite water tanks. The raw water reservoir is 100 ft. diam. by 24 ft. high, and the two treated water tanks are 70 ft. diam. by 24 ft. high. Transite pipe with lined Streed fittings was used in the entire water supply system.

Ebasco Services, Inc. of New York City, under the direction of Rayonier engineers, designed the mill facilities and managed the construction of the mill. Clarence Jones of Jesup performed the excavation and grading.

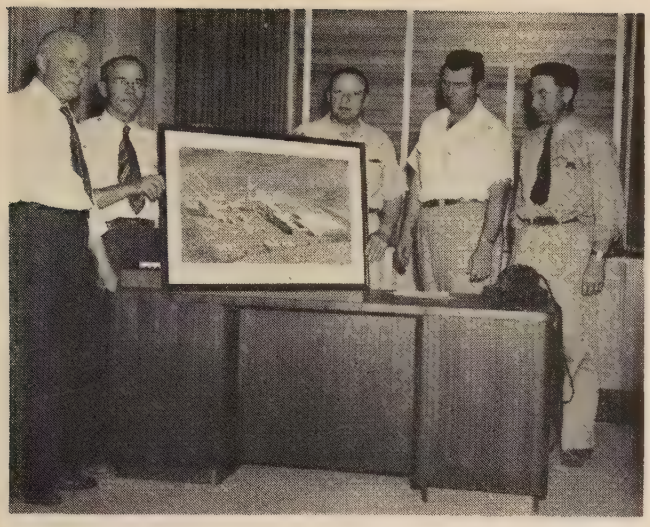
Bristol Steel Co. fabricated and erected the structural steel, and the J. A. Jones Construction Co. constructed the buildings and equipment foundations. Eichleay Corp. erected the equipment, and Rowland Thompkins and Son installed all of the piping. The electric installation was performed by Rollinson Engineering Co. of Savannah.

The mill office building is a two-story brick structure approximately 75 ft. front by 36 ft. deep, connected by a covered breezeway to the laboratory building which is a single-story brick unit approximately 68 ft wide by 120 ft. long. Both buildings are air conditioned. The laboratory is equipped with the finest and most modern equipment available for exacting pulp testing techniques.

Employee facilities are housed in an attractive, combination brick and structural glass, single-story building 90 by 100 ft., which includes locker and shower facilities as well as air-conditioned offices for the personnel department and timekeepers. It also includes a large conference room for safety program activities as well as large, attractive first aid quarters which are fully equipped to provide the finest emergency treatment. The first aid facilities are staffed with trained attendants.

Paper Company Statistics

The following paper companies are among the 50 chemical process companies listed by *Industrial and Engineering Chemistry* as having the most rapid growth during the period 1951–



C. A. Harwick, (left) manager of the Industrial Engineering Department of Ebasco Services, Inc., and A. P. Schnyder, Ebasco's pulp and paper mill specialist are shown presenting a painting to T. R. Stein, (center) manager of Rayonier, Inc.'s new Jesup, Ga. plant, as R. J. Kutchera (fourth from left) Ebasco's project engineer on that job and R. J. Christensen, Ebasco's resident engineer look on. The painting of the new chemical cellulose mill was done by Earl Bishop, an Ebasco architect

53: Marathon Corp., Kimberly-Clark Corp., Crown Zellerbach Corp., Champion Paper & Fibre Co.

The rate of profit in stockholder's equity after Federal income tax and excess profits taxes for paper and allied products was 14.0% in 1951, 10.5% in 1952, and 10.0% in 1953. Ratio of funded debt to total capitalization was 12.2% in 1951, 14.5% in 1952, and 16.9% in 1953. Dividend yield as per cent of pulp and paper common stock prices was 3.7 in 1939, 5.1 in 1951, 5.1 in 1952, and 5.2 in 1953. Net sales per dollar of original cost of plant and equipment amounted to $0.49 in 1939, $1.23 in 1951, $1.14 in 1952, and $1.08 in 1953. Dividends in the paper and allied products field expressed as a per cent of net profit after Federal income and excess profits taxes were 35.1 in 1951, 44.9 in 1952, and 45.1 in 1953. The ratio of current assets to current liabilities for paper and allied products was 2.30 in 1951, 2.40 in 1952, and 25.8 in 1953. Net income as a per cent of pulp and paper sales was 7.0 in 1939, 9.8 in 1951, 8.8 in 1952, and 8.0 in 1953. Depreciation expressed as a per cent of depreciated value was 5.7 in 1939, 7.2 in 1951, 7.4 in 1952, and 8.0 in 1953.

—From *Industrial and Engineering Chemistry* June, 1954.

The Regulator in the Paper Mill

Papermaking has always been an art. In paper and paper products the variety of texture, weights, shades, and physical characteristics has been possible only by application of specialized knowledge and experience. The correct valve must be opened the correct amount to allow the correct proportions of ingredients to mix under correct conditions. This combination of knowledge and experience still is necessary for making decisions as to the proportions of chemicals and conditions of manufacture; but, in a rapidly increasing number of plants, instruments measure the conditions and automatic control valves set the flow rates of chemical coolants and heating media. This discussion concerns the regulators and control valves which allow us to take full advantage of the know-how of the veterans in the industry.

Valve Design Standards

Valve designers attempt to accomplish the following in their regulators and control valves:

1. Minimum hysteresis in positioning the valve.
2. Structural design to satisfy pressure and temperature ratings without excessive weight.
3. Power sufficient to overcome unbalanced forces to allow valve to position correctly.
4. Easy access to parts subject to wear.
5. Close regulation over wide variations in flow rates.
6. Ease of changing setting.
7. Interchangeability of parts.

It is advisable to apply the principle of selecting the simplest control method that will satisfy the application. Using this approach, there are many applications for the plain, old (this is said reverently) pressure regulator. It is so useful that it always should be considered.

Instrument Air

Instrument air must be furnished to each panelboard, transmitter, or locally mounted controller at approximately 20 p.s.i.g. from the instrument air distribution system. This instrument air distrubution system, which is usually supplied from one compressor, must be protected with a regulator between the plant air supply and the instrument air system. In the absence of a separate instrument air distribution system, a pressure regulator is installed on laterals connected to the plant air system in various locations throughout the plant.

Level Change

Wide use of the bubbler system of measuring liquid level requires the use of additional pressure regulators. Close control of bubbling rate can be obtained with a rotameter and differential regulator. By this method, change in liquid level does not affect the rate of bubbling; consequently, a more accurate measurement is obtained.

Air is used to unload chemical tank cars. A pressure regulator assures that air is supplied in sufficient but not excessive pressure for the service. Pressure regulators are necessary in locations (such as intermediate temperature heat exchangers or fuel oil tanks) throughout a plant where steam is required at a pressure lower than that available from the supply line in that area. Water can be supplied at different pressures by using a regulator on the lateral line connected to a high pressure water service.

Constant Water Pressure

The back pressure regulator, which is the antithesis of the reducing regulator, is used to maintain a constant water pressure by relieving the discharge of a pump back to suction. This method, using a back pressure regulator, can be used to forestall excess pressure caused by decreasing water usage. Increase in pressure may cause lifting the bed of a filter or the chemical bed of a zeolite treater.

Condensate Removal

Removal of condensate from steam heaters requires careful consideration. A wide range of capacity, with greatly varying pressure differentials, is usually required. This requires what may seem to be an oversized valve for the capacity with consequent difficult operation at maximum pressure drop. In the use of an internal heater for heating digester liquor, the rate of steam condensate removal is rapid at the start of the "cook." At this time the effective steam pressure is low, requiring adequate valve size. As the liquor and chips approach the maximum temperature, steam consumption is low, while maximum pressure drop occurs between the steam heater and the condensate collection system. This service may require a level controller and air-operated controller valve, although many of these installations are adequately served with a direct-operated ball float. The use of stainless steel, glass or ceramic floats permits the simple level valve to be used in many corrosive liquid applications.

Temperature Regulation

The direct-operated or pilot-operated temperature valve has many applications in paper mill work. It can be used to con-

trol the heating of water for the causticizing and washing sections; to heat fuel oil for stand-by boiler service and the lime kiln. This type of valve is also used to control heat exchangers such as the one used for heating the black liquor for the recovery boilers. Heating of chemical solutions is often necessary to further or speed the chemical reaction and to increase the solubility in order to obtain a higher concentration.

Process instrumentation throughout the paper mill requires the use of many diaphragm control valves. These may be Saunders patent, butterfly, or the traditional globe valve.

—by Chester S. Beard, Foster Engineering Co., Union, N. J.

Packaging Machinery

The manufacturing trend today is to speedier packaging lines to reduce costs and minimize finished product inventories. New methods of merchandising and distribution are constantly in the process of evolution, for management can never be complacent about its methods or ideas.

And the key to this trend is in replacing production personnel with automatic machines. One of the important factors in packaging costs is the labor required to handle the package on the production line. In our particular operation, we find that the average operator on a package line costs us $1.50 per hour including wages and fringe benefits. Our operators work a 40-hour week.

However, considering morning and afternoon breaks, seven paid holidays a year, and two weeks vacation with pay, we find that our operators work only 25 hours per week but are paid for 40 hours. Therefore, operator costs are actually $1.70 per hour.

On this basis, when a semiautomatic or automatic packaging machine replaces an operator, there is a saving of $3120 a year if the machine is in daily operation. Obviously, this saving or any portion of it, depending on the use of the machine, will amortize the equipment.

This is a basic principle of good plant management. Yet, I constantly see operations where hand labor can be replaced by a semiautomatic machine or an attachment to a piece of equipment. An automatic unit in place of semiautomatic may replace one or two operators. Another aspect of this is the actual saving involved. How much effort and money would your company spend to obtain an additional net profit of $3120 a year? From the roughest estimate, your sales increase would have to be between $50,000 to $75,000 annually.

Looking at the human element on the package line, it is good practice to have the speed of a line placed uniformly to obtain the most efficient operation possible. Consequently, the lead equipment in the line should not depend on the human element to set its speed. No supervisor worth his salt will condone an operation of automatic equipment where his operators determine the speed of the line.

As an example of this, I recall a case where bottles on a line were fed manually from reshippers by two operators. The speed of the line varied from 88 to 108 bottles per minute. An automatic unscrambler was inserted into the line. Today that line averages 120 bottles per minute and has one girl operator. It's a good axiom to have the machine pace the line and not the operators.

In another case, a packaging line is running day and night shifts with nine operators on each shift. The company concerned is currently changing over to a new high-speed automatic line, which will eliminate the need for the night shift. The elimination of the night shift alone will pay for this line in two-and-a-half years and I'll warrant that the efficiency of the new line will be greater than the average of the two shifts.

—by John A. Warren, American Home Products Corp., New York, N. Y.

1 Lb. of Coal Produces 1Kw.

In April, 1954, the "coal rate" of all coal-burning utility stations reached exactly 1 lb. per kw. This result was recently officially announced by the Federal Power Commission. This marks a milestone in power generation. It took 3 lb. of coal to generate a kilowatt in 1920; by 1925 the average was 2 lb., and the 1953 average was 1.06 lb. per kw.-hr.

In these compilations, 1 lb. of coal is considered to contain 13,100 B.t.u. as fired. In other words, in the month of April the "heat rate" was 13,100 B.t.u. per net kw.-hr. The most efficient plant, as reported by the "Eight Steam Station Cost Survey," has a heat rate of 9304 B.t.u. per net kw.-hr. The average boiler efficiency in this plant was 90% and the overall efficiency of the station was 36.68%. The boiler pressure is 2000 p.s.i.g. and the steam temperature is 1050°F. with 1000°F. reheat. The coal rate of this station is 0.71 lb. per kw.-hr.

Even more efficient stations are being planned. There will be a continuing gradual trend downward in the ratio as older stations are replaced with the newer, more efficient ones.

Carbonless "Carbon Paper"

The new carbonless "carbon paper," widely announced recently, makes copies by means of a chemical treatment applied in two separate parts.

First, a rupturable solid film of gelatin, for instance, containing minute droplets of oil, is coated on the paper base. The oil droplets contain a colorless oil-soluble dye derivative and are released when the film is broken by the typewriter or pencil stroke. Second, a layer of some acidic adsorbent is added, either in the body of the paper, or as a separate layer, perhaps on a separate undersheet. The released oil droplets are adsorbed onto the surfaces of the coating, and a color results. In effect, the oil droplets contain materials that need only this contact with an acid to be changed into a colored state.

Shutting down a sulphur burner for repairs can be a costly project because of the sometimes serious interruptions to production. Brief shutdowns may result in temporary or inadequate repairs.

At American Maize-Products Co., of Roby, Ind., the company faced a 6-months shutdown of its burner and absorption tower recently when a building renovation project was necessary. American Maize avoided the shutdown by means of a liquid sulphur dioxide installation set up by Ansul Chemical Co., Marinette, Wis., which assigned the tank car, pictured above, to American Maize for the duration of the construction. The tank car was refilled regularly with liquid SO_2 transported to the scene by a tank truck.

Although American Maize found it somewhat more expensive to buy liquid SO_2 than to operate a sulphur burner, the cost was considerably less than that which would have been incurred by shutting down the burner and idling the plant. Ansul engineers say the same technique can be applied to pulp and chemical plants that face sulphur burner shutdown problems

In practice, a sheet of paper may be coated on one side with attapulgite clay, an acid material, and on the other with the gelatin film. When a number of sheets are piled up, writing on the top sheet ruptures the gelatin film on the under side of all sheets beneath. Oil droplets are transferred on to the clay particles on the top sides of the sheets below, and blue reproductions of the written characters are formed. In another scheme, the clay film is coated directly on the top of the gelatin, with both layers on the top side of the sheet. When pressure is applied, the gelatin film is broken and the oil droplets contact the clay particles immediately above. To date, there is no good indication of the cost of this chemically treated copy paper, but its makers expect it to compete with carbon paper for forms and sales books. It is not expected to substitute for record carbons of correspondence, memos, etc., in the near future, in view of the probable cost and the necessity for coating letterhead papers.

Hardwood Pulping Conference

The Northeastern Wood Utilization Council is holding a conference on the pulping of hardwoods at the University of Massachusetts, Amherst, Mass., on September 14. This will be a practical down-to-earth conference featuring reports by mill men who are producing various grades and kinds of pulps from hardwoods. As space is limited, it is suggested that those interested in attending write Prof. R. B. Parmenter, University of Massachusetts, Amherst, Mass., being sure to indicate if they require overnight accommodations.

F.P.L.

Paper experts at the U. S. Forest Products Laboratory, Madison, Wis., are literally "handling with gloves" a shipment of wood sent air express from Pakistan for tests of its suitability for papermaking.

The reason for the gloves:

The wood comes from the "blinding tree of India." Handled by the unwary, it can cause severe skin blisters and eye irritations. A milky white substance in the bark similar to the latex obtained from rubber trees is responsible. Its effects are much like those of the common poison ivy.

Native Pakistanian and Indian woodcutters have long been accustomed to handling the tree and its logs with gloves. Once the bark is completely off and the wood seasoned, however, danger of irritation is past. The wood is used for construction, furniture, toys, and shipping boxes in the Orient.

The Pakistan Industrial Development Corp. sent 800 lb. of the wood to the F.P.L. at a cost of $1400 in air freight charges.

Shown above is the panel of paper mill men who participated in the semi-annual sales meeting of the Albany Felt Co., Albany, N. Y. Left to right are: Ken Osborn, superintendent of Ohio Boxboard Co., Rittman, Ohio; Harold Bragdon, Assistant Purchasing Agent of S. D. Warren Co., Cumberland Mills, Me.; Jim Smith, Assistant Sales Manager of the Albany Felt Co., Albany, N. Y.; and Leonard Parkinson, superintendent of Rhinelander Paper Co., Rhinelander, Wis. The purpose of these meetings, which are one phase of a comprehensive sales training program, is to emphasize the importance of helping the paper industry to obtain a lower percentage of waste along with faster machine speeds

B. Francis Kukachka, wood identification expert, examines a bolt of geva wood from Pakistan, shipped to the U. S. Forest Products Laboratory here for tests of its suitability for papermaking. The bark of the tree, relative of the rubber tree, gives off a milky latex that blisters the skin and irritates the eyes, much like poison ivy

Each bolt was carefully wrapped in burlap to prevent infection of handlers.

To natives of its growth area the tree is known as geva or gangwa. Botanists call it *Excoecaria agallocha* Linn. It is a member of the same family, *Euphorbiaceae*, to which the rubber tree, *Heva brasiliensis*, also belongs. Some 75 species of the genus *Excoearia* are distributed throughout the tropics of both western and eastern hemispheres, according to Dr. Jeannette Kryn of the Laboratory staff.

The wood received at the Laboratory was dry and bark-free. Nevertheless, a day or two after B. Francis Kukachka, Laboratory wood identification expert, examined it he came up with a couple of skin blisters on one hand because of inner bark left on the piece.

It is planned to run pulping trials by various processes and make newsprint and magazine papers of the wood. Laboratory technicians are keeping their gloves on as they put it through various papermaking tests!

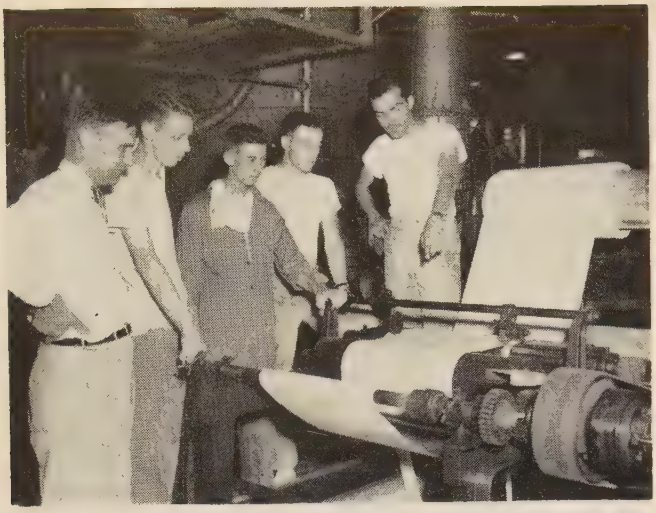
EDSA

Joel B. Ware of Flossmoor, Ill., has been appointed deputy director of the Forest Products Div., Business and Defense Services Administration.

Western Michigan

Four new scholarships have been created in paper technology at Western Michigan College. Three of them are for $200 each year and are renewable throughout the college course, dependent on academic standing.

Donors of these awards are Moore and Munger of New York; the Charles E. Nelson Memorial award, honoring the late president of the MacSimBar Paper Co., Otsego, Mich., and the L. H. Breyfogle scholarship, given by friends to



R. C. Sproull, director of the Herty Foundation, Joseph McCaffrey, North Carolina State, Henry LaRoche, Armstrong College, John Hester, North Carolina State, and G. N. Kemp, pilot plant superintendent, Herty Foundation

honor a long-time paper mill worker and salesman to the paper industry.

The fourth award is a $500 a year award given by the Black-Clawson Co., Hamilton, Ohio, to be granted on a competitive basis each year to the child of an employee. Under the terms of the grant the student must follow a paper technology course, specializing in paper mill machinery. This is a renewable award for the college course.

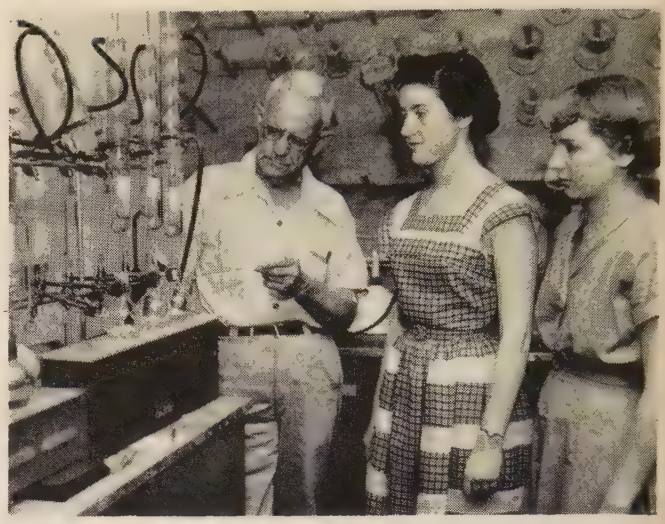
Medicine from Wood Pulp

Chemicals from wood pulp and soybean plants have been found useful in lowering the amount of cholesterol in the wood. Research workers at the University of Louisville Medical School think that these substances may be used to combat high blood pressure, which is believed to be caused by hardening of the arteries brought on by excess cholesterol.

Lowell Tech.

Norman E. Scott, secretary, Boston Paper Trade Association and New England Paper Merchants' Association, presented the annual two scholarships to students enrolled in the Paper Engineering Course at Lowell Technological Institute in June.

Prof. John Lewis, Head, Paper Engineering Division, President Martin J. Lydon, Norman E. Scott, Fred D. Iannazzi, Richard C. Savage, and Dean R. W. Ivers of the Lowell Technological Institute



R. H. Stevens, research associate at the Herty Foundation laboratory with Barbara Calhoun and Linnelle Thurman, seniors at Berry College, Mt. Berry, Ga.

Fred D. Iannazzi received the $150 New England Paper Merchants' Association Scholarship, which will cover his tuition for his senior year at the Institute. Richard C. Savage received the Boston Paper Trade Association Scholarship for $150, which will cover his tuition costs for his sophomore year at the Institute.

University of Maine

The University of Maine, Orono, Me., at its commencement exercises on June 20, awarded an honorary degree of Doctor of Laws to Manuel C. McDonald, president of the Great Northern Paper Co., Millinocket, Me., in recognition of his outstanding career in industrial management.

Transparent Packaging

Hearn's Department Stores in New York have been experimenting with transparent packaging to facilitate self-service selling. The experiment has been so successful that the company has decided to broaden its scope to cover as many items as lend themselves to packaging of this type.

Packaging and Transportation

A symposium on the transportation, packaging, and labeling of chemicals will be presented October 13 during the Eighth National Chemical Exposition in the Chicago Coliseum October 12–15.

Herty

The Herty Foundation, Savannah, Ga., is cooperating with the North Carolina State College, Division of Pulp and Paper, to give students a practical course in pulp and paper manufacture. Five students are taking the course, which includes wood preparation, mechanical and chemical pulping, pulp evaluation, bleaching, pulp refining, and papermaking.

Huyckfelt

Compressive shrinkage blankets manufactured by F. C. Huyck & Sons, Rensselaer, N. Y., for use in Sanforizing Trademark Cluett Peabody Co. are now being shipped in fiberboard containers. This new use of a paper product replaces wood cases and is the culmination of an extensive testing program conducted by Huyck engineers.

The fiber drums provide maximum strength with minimum weight. They have an extremely smooth inner surface which insures protection against snagging and abrasion, and are free from contamination from any source. The main advantages to textile mills are the ease of handling, storing, and unpacking which the drums afford.

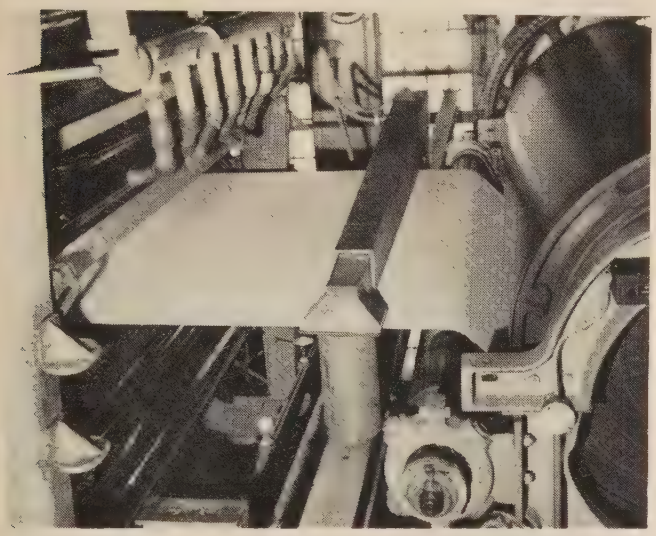
Plastic Plant Windows

Explosion-vent windows of extruded Tenite butyrate plastic are new aids to industrial plant safety manufactured by General Plastics Co., Marion, Ind. from plastic marketed by Eastman Chemical Products, Inc., Kingsport, Tenn.

In the event of a blast caused by sudden ignition of gas or air-borne dust, the flexible panes bow and pull away from the casings to effect a quick release of pressure. Since the panes don't shatter, there is no flying-glass hazard.

Industrial Nucleonics

A traversing AccuRay beta gage on a paper machine at Beckett Paper Co., Hamilton, Ohio, has reduced basis weight



variation by 50%. The scanning unit moves slowly across the full width of the sheet and registers its reading on a strip chart recorder. It then retracts quickly and repeats the measuring cycle.

Molded Plastics

Molded Plastics, Inc., Cleveland, Ohio, is offering Structoglas building panel in which decorator patterns are incorporated. The panels are available in flat and corrugated sheets.

Farley & Loetscher

Farley & Loetscher Mfg. Co., Dubuque, Iowa, is manufacturing its $^1/_{16}$-in. Farlite decorative laminates in three new patterns: Charm, Madrid, and Nubbe.

Polyplastex

Polyplastex United, Inc., New York, N. Y., is marketing a line of vinylite sheeting laminated with decorative sheets of fabric, Fiberglas, yarn, etc. under the name Pan Laminates.

Colors for Nylon and Fluorocarbons

Ferro Corp., Cleveland, Ohio, has developed a line of inorganic heat-resistant colorants for use in such resins as nylon and fluorocarbons.

Metal & Thermit

Metal & Thermit Corp., New York, N. Y., has developed a new low pigmenting process antimony-containing derivatives M. & T. Flame Retardant for use in formulating flame-resistant compounds.

Tracerlab

Tracerlab, Inc., Boston, Mass., manufactures a light materials beta gage, designated BG-5, for measuring the basis weight of cellophane, pressure-sensitive tapes, and other very thin materials.

Instron

Instron Engineering Corp., Quincy, Mass., is offering a tensile tester based on electronic principles, which automatically plots load versus elongation over a range of 2 grams up to 5000 lb.

Hendrick

A saw which passes over the stock instead of having the stock pass over the saw is manufactured by Hendrick Mfg. Corp., Marblehead, Mass., for use in cutting large sheets of plastic to exact size.

Dake

Dake Engine Co., Grand Haven, Mich., manufactures a line of hydraulic platen presses in sizes from 25 to 300 tons.

South Florida Test Service

Weathering tests of all types are carried out by South Florida Test Service, Miami, Fla.

Roots

Franklin F. Bogardus has been appointed district manager in the Chicago office of the Roots-Connersville Blower division of Dresser Industries, Inc. Richard L. Tannehill is now district manager in the Cleveland office.

RCB has introduced a self-cleaning evaporator designated SEBAVA, which has been used in Europe for 15 years. Featuring stainless steel wipers which prevent scale formation and enhance evaporation, the unit is available in capacities from 65 to 6000 lb. per hour. Present European uses of the evaporator are said to include spent sulphite liquor concentration, sea water distillation, and crystallization of sodium chloride, caustic soda, and boric acid from aqueous solution.

Sandoz

A. T. Hanes, Jr. has been named vice-president in charge of sales of Sandoz Chemical Works, Inc., New York, N. Y.

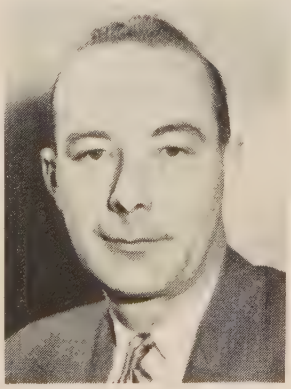
Sandwell

Sandwell & Co., Vancouver, B. C., has been engaged by the Pakistan Industrial Development Corp. to investigate the possibility of a pulp and paper development in East Bengal.

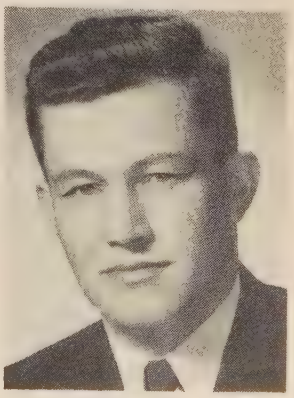
S. D. Ford, assistant chief engineer for Sandwell, returned recently from Europe where he and P. J. Vakomies, Sandwell project engineer, were engaged in arranging with European manufacturers of process equipment for the Murapara project in New Zealand.

Magnus

Robert L. Kaiser has been appointed marketing and development manager of Magnus Chemical Co., Garwood, N. J.



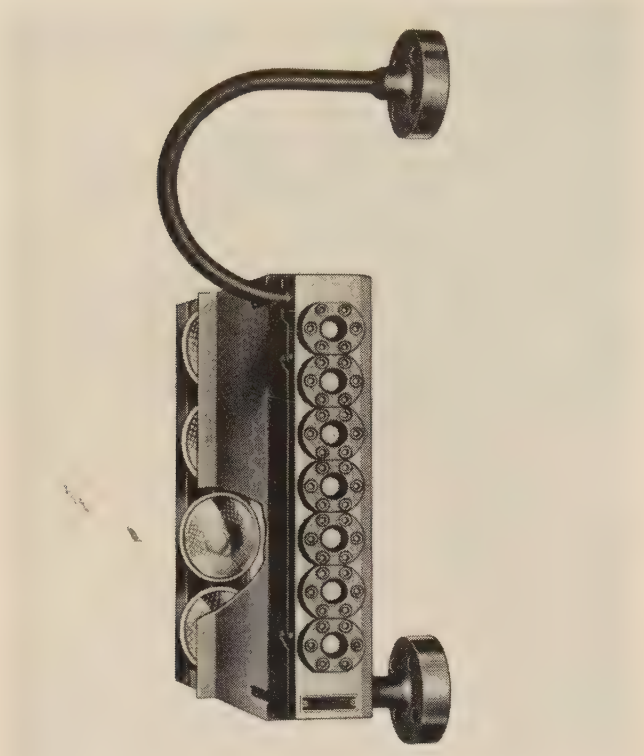
S. D. Ford, Sandwell & Co., Ltd.



R. L. Kaiser, Magnus Chemical Co.

DIAMOND POWER

Diamond Specialty Corp., Lancaster, Ohio, has developed a



New Diamond "Multi-Port" bi-color gage for boiler operating pressures up to 3000 p.s.i.

new Multi-Port gage for water level indication in high pressure boilers.

P & J

Pusey and Jones Corp. are supplying high pressure 60 by 192-in. driers to the Fraser Paper Co., Madawaska, Me., for

New high-pressure driers just before shipment from the Pusey and Jones Corp. to Fraser Paper Co., Ltd., Madawaska, Me.

use in the new Pusey-Jones fourdrinier MG and MF paper machine.

J-M

Johns-Manville Corp. has opened a new laboratory at Manville, N. J., devoted to research and development of asbestos brake linings and other friction materials.

J-M is making an addition to its Waukegan, Ill., plant which will double its capacity of passenger car and industrial friction materials in 1955.

ORTHMANN

The Orthmann Laboratories, Inc., 922 N. 4th St., Milwaukee, Wis., is celebrating its 25th anniversary.

LINDSAY

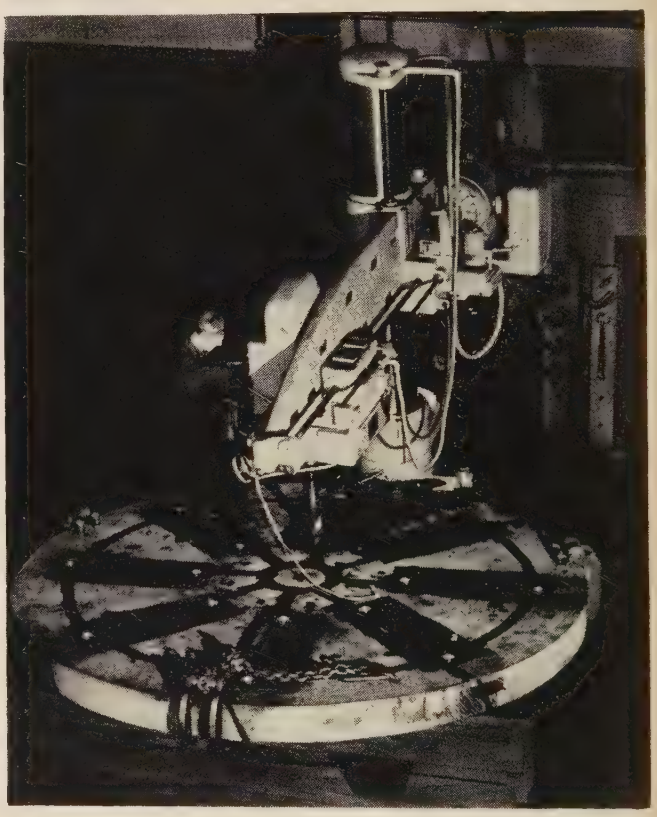
The Lindsay Wire Weaving Co., Cleveland, Ohio, has issued an illustrated booklet on the occasion of its 50th anniversary.

DIAMOND ALKALI

William H. Evans has been appointed vice-president of Diamond Alkali Co., Cleveland, Ohio. John W. Mantz has been made general manager of Diamond's silicate, detergent, and calcium division. L. T. Welshams has been named general manager of the cement and coke division, C. R. Brown is now assistant general manager, and Robert McConnell is manager of industrial relations.

D. J. MURRAY

D. J. Murray Mfg. Co., Wausau, Wis., recently supplied a 150-in. eight-knife chipper to a Washington mill.



This big steel disk, 12½ ft. in diameter and nearly a foot thick, rolled by Lukens Steel Co. of Coatesville, Pa., will soon be chopping up 150 cords of western hemlock logs an hour for wood pulp used in producing rayon. Designed and built by D. J. Murray Mfg. Co. of Wausau, Wis., the machine will have eight knives, will turn a log 3 ft. thick and 20 ft. long into a pile of chips in about 10 sec. The completed machine—one of the largest of its type ever built—was recently shipped on two specially-designed flatcars to a Washington pulp mill

Officers of the D. J. Murray Co., Wausau, Wis., are as follows: A. W. Plier, president and general manager; M. P. McCullough and D. C. Everest, vice-presidents; W. A. Marquardt, secretary; G. L. Ruder, treasurer; P. W. Hoeper, assistant secretary, and Fred C. Boyce, assistant treasurer.

STALEY

Paul Breyfogle has been appointed technical assistant in industrial sales of the A. E. Staley Mfg. Co., Decatur, Ill. Byron Fast has been named sales service engineer, and Robert C.

W. H. T. Furry, The Foxboro Co.

M. B. Hall, The Foxboro Co.

Hanna has been appointed industrial sales representative in Dallas, Tex.

FOXBORO

The Foxboro Co., Foxboro, Mass., has completed a new 15,000-sq. ft. plant at 2270 Noblestown Rd., Pittsburgh, Pa., which will double the present instrument assembly, service, and repair facilities. This is the second of three plants to be erected this year. A new plant in Dallas, Tex., was opened in April and another in San Leandro, Calif., is being completed this month.

W. H. T. Furry has been named director of the training and educational division of The Foxboro Co., succeeding Malcolm B. Hall who recently completed 40 years of service with the firm.

DOWNINGTOWN

Downingtown Mfg. Co., Downingtown, Pa., has issued a bulletin (No. 454) entitled "Pulping Phase of the Downingtown Stock Preparation System."

I-R

Ingersoll-Rand Co., New York, N. Y., has introduced a 75 to 100-hp. packaged air compressor, and has issued a pamphlet (Form 3155) describing its features.

G.E.

General Electric Co., Schenectady, N. Y., has formed two new company organizations, a meter department at Somersworth, N. H., and an instrument department at Lynn, Mass.

H. F. McCullough, G.E.'s manager of Service Shops, predicted recently that industry will double its maintenance expenditures in the next 10 years.

A new G. E. publication (GEA-6087) is entitled "Five Steps to Productive Maintenance."

G.E.'s Chemical Div. in Pittsfield, Mass., has available in pilot plant quantities irradiated polyethylene, which has greater heat and chemical resistance than normal polyethylene.

HOOKER

Hiram B. Young has been appointed vice-president in charge of eastern production for Hooker Electrochemical Co., Niagara Falls, N. Y. Thomas E. Moffitt has been named vice-president in charge of western operations. Newly appointed works manager of the Niagara plant is F. Leonard Bryant.

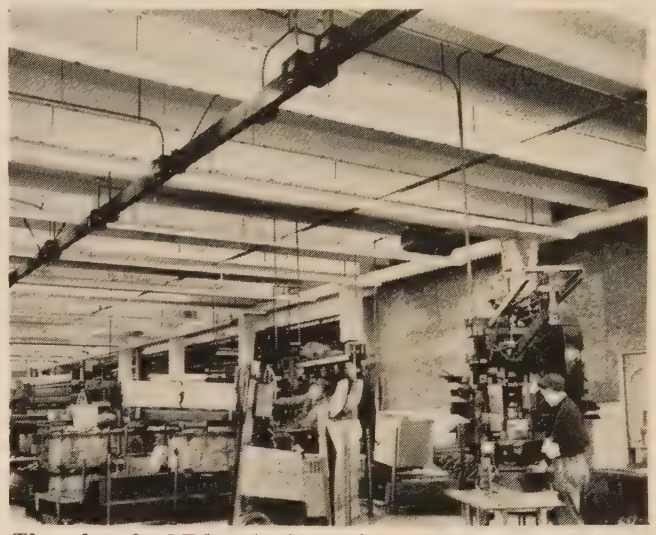
Richard F. Graham has been appointed sales representative for Hooker in the Wilmington, Calif., office.

Hooker has opened a new $12 million chlorine-caustic plant at Montague, Mich.

A new series of tough, corrosion-resistant polyester resins, trade-named Hetron, has been developed by Hooker with this outstanding feature: fire resistance combined with light stability. The resin can be combined with fibrous glass for plastic car and truck bodies, corrugated and flat panels for indoor and outdoor architectural uses.

FIBERGLAS

Owens-Corning Fiberglas Corp., Toledo, Ohio, has appointed Culberg Asbestos and Cork Co., 1402 N. Halsted St. Chicago, Ill., as a distributor of Fiberglas industrial insulations.



Three hundred Fiberglas Noise-Stop Baffles are hung from the ceiling in the new plant addition of The F. W. Wakefield Brass Co., Vermilion, Ohio, to absorb the sound waves resulting from punch press operations. In addition 1400 sq. ft. of Fiberglas PF-616 insulation were placed on one side wall to eliminate echoes that formerly bounced back from the masonry wall into the working area

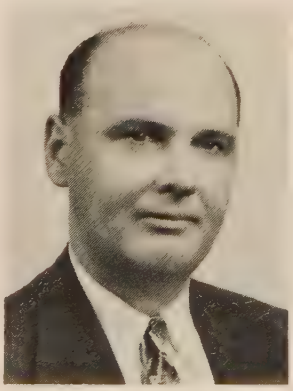
Fiberglas Noise-Stop Baffles have been installed in the new plant addition of the F. W. Wakefield Brass Co., Vermilion, Ohio, to reduce the noise from punch press operations.

BLACK-CLAWSON

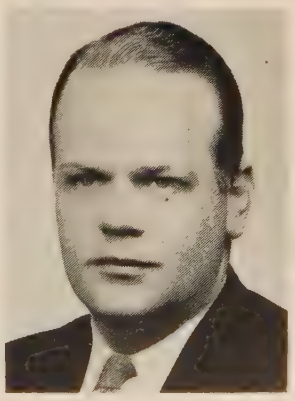
R. R. Crawford, Shartle Bros. Machine Div., Black-Clawson Co., Middletown, Ohio, has left for England to assume office as general manager of Black-Clawson International, Ltd., London.

Frank T. Peterson, vice-president of Black-Clawson, has returned to New York from an extensive visit through the European paper industry, during which he completed arrangements with De Forenede Papierfabrikker, Copenhagen, Denmark, for the furnishing of a new cylinder board machine and a stock preparation system.

The new Black-Clawson equipped paperboard mill of Fiskeby Fabriks Aktiebolog, Norrkoping, Sweden, was formally opened on May 14, 1954. This machine produced salable board 46 minutes after its initial start-up earlier this year.



R. R. Crawford, Black-Clawson International, Ltd.



F. T. Peterson, The Black-Clawson Co.

FERGUSON

The H. K. Ferguson Co., Cleveland, Ohio, has formed a new British company to be known as H. K. Ferguson Co. of Great Britain, Ltd., with headquarters at 19 Berkeley St., London. Raymond B. Aufmuth is chief engineer of the new firm.

HERCULES

Hercules Powder Co., Wilmington, Del., has published a booklet on Vinsol resin for use as a modifier in various adhesives.

Edwin S. Moler and Robert C. Bogott have joined the development group of the Hercules synthetics department.

DOW

Dow Chemical Co., Midland, Mich., has developed a fire-retardant coating designated Dow Latex 744-B, having decorative and durable properties.

WHITING

Bernard L. Heinen has been assigned to the Houston, Tex., district office of Whiting Corp., Harvey, Ill. Ernest V. Piazza is now at Whiting's St. Louis district office; Charles D. Schmidt is at the New York district office; and A. C. Patsavas is at the Cincinnati district office.

BECCO

Becco Sales Corp., Buffalo, N. Y., has reduced the price of hydrogen peroxide by about 6% on tank car lots.

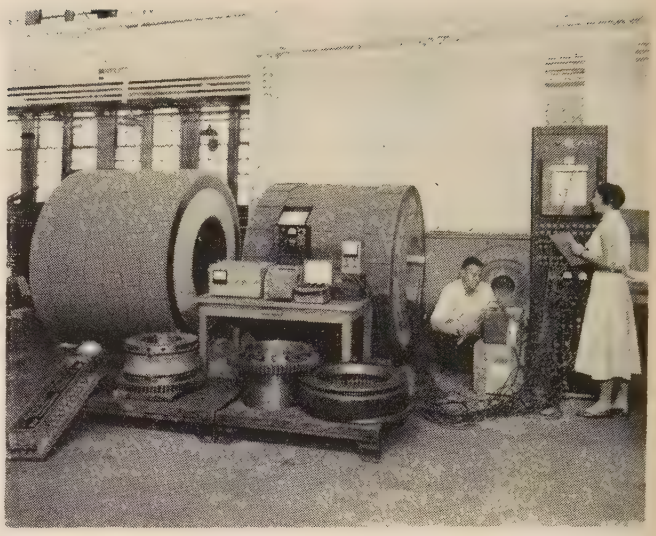
RELIANCE

Reliance Electric and Engineering Co., Cleveland, Ohio, has issued a bulletin (K-2076) describing Reliance VSR, a regulator for speed, voltage, and current regulation for industrial electric motor drives.

NORTON

The Norton Co., Worcester, Mass., has completed a "guinea pig" pulpstone to be installed at Great Northern Paper Co., Millinocket, Me. Electrical devices are placed within the stone to measure stresses and temperatures under grinding conditions, and transmit these measurements to an instrument panel via slip rings connected to 93 wires. Great Northern has taken an active part in the whole program, and built the hollow shaft which carries the wires to the external instruments.

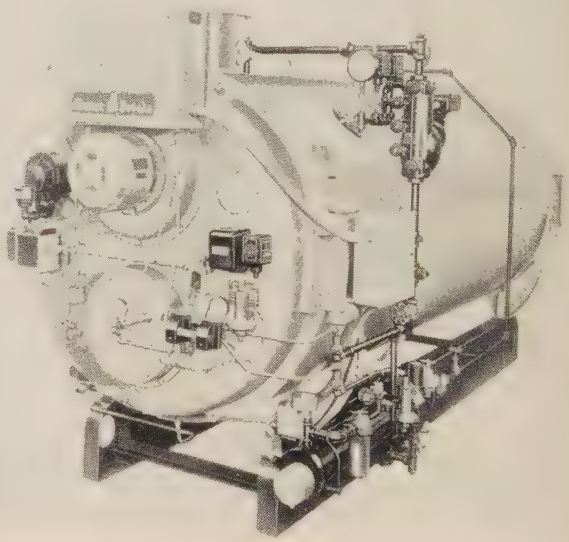
Physicist, Marion Kraft, checks electrical circuits installed in a "guinea pig" pulpstone. Mrs. Kraft is one of several Norton engineers and research workers who will study this stone in operation at the Great Northern Paper Co.



Norton research workers, Karl Kalbfleisch and Marion Kraft, check out circuits in the test pulpstone which has been made to analyse conditions of temperature and stress within the stone during actual operation. The slip ring assembly, shown at front left, will be installed at the end of the mounting shaft to collect electrical signals from the rotating stone and transmit them to the recording equipment

CLEAVER-BROOKS

The Cleaver-Brooks Co., 326 E. Keefe Ave., Milwaukee, Wis., has extended its new CB line of boilers to include units



Cleaver-Brooks CB boiler

of 50, 60, 70, and 80 hp. capacity, and has issued a pamphlet (bulletin AD-135) describing the new units.

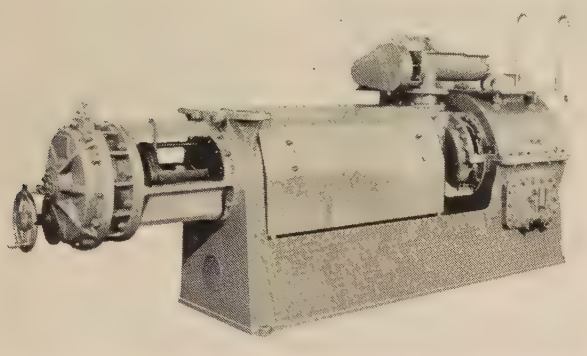
HEPPENSTALL

Heppenstall Co., Pittsburgh, Pa., recently gave awards to four of its representatives for outstanding work: John D. Robinson Co., Savannah, Ga., for the sale of industrial knives; Brace-Mueller-Huntley, Inc., Buffalo, N. Y., for sale of hot-

work die-steels; the Pittsburgh district sales office for sale of materials handling equipment; and the Chicago sales office for accuracy in sales forecasting.

BAUER

Bauer Bros. Co., 1715 Sheridan Ave., Springfield, Ohio, has issued a bulletin (P12) describing the Pressafiner, a new con-



The Pressafiner, Bauer's new continuous screw press

tinuous screw press for expressing fluids from cooked wood chips.

DU PONT

Penn R. Lindsay has been appointed manager of the Cincinnati district sales office of the du Pont Electrochemicals Dept., succeeding Joseph M. Christie, who has retired.

Elvadex vinyl polymer, du Pont's new alkali-soluble vinyl acetate copolymer is now available in commercial quantities.

A booklet describing the properties of Mylar polyester film has been published by du Pont's Film Dept., Wilmington 98, Del. Mylar is a transparent film of great mechanical strength, heat resistance, chemical inertness, and dielectric strength.

MONSANTO

Monsanto Chemical Co.'s Plastics Div. has added polyvinyl acetate to its line of industrial adhesives, under the designation Lauxite 301.

B & O

The Baltimore and Ohio Railroad has started a service for handling highway trailers on flat cars to provide door to door trailer service in the major cities on its system.

PERKINS

B. F. Perkins & Sons, Inc., Holyoke, Mass., has opened a southern sales division in Charlotte, N. C., under the management of Benjamin C. Trotter.

REICHHOLD

Reichhold Chemicals, Inc., 525 N. Broadway, White Plains, N. Y., has appointed the C. Withington Co., 29-28 41st Ave., Long Island City, N. Y., as its district sales agent.

CARBORUNDUM

Semon H. Stupakoff has been elected vice-president of the Carborundum Co., Niagara Falls, N. Y.

DE LAVAL

The De Laval Stream Turbine Co., Trenton, N. J., has published a bulletin (No. 4202) describing De Laval velocity stage class CA turbines.

SOLVAY

The Solvay Process Div., Allied Chemical & Dye Corp., 61 Broadway, New York, N. Y., has issued a bulletin (Technical and Engineering Service Bulletin No. 9) on the Analysis of Alkalies.

SEMET-SOLVAY

Semet-Solvay Petrochemical Div. of Allied Dye and Chemical Corp., New York, N. Y., has developed a low molecular weight polyethylene to improve the gloss of bread wrappers.

A-C

Thomas C. Knudson has been appointed assistant to the general manager in charge of the mechanical product development laboratory at the Norwood Works of the Allis-Chalmers Mfg. Co., Milwaukee, Wis. Vernon B. Honsinger has been named assistant to the general manager in charge of the electrical product development laboratory, and Dwight H. Lory is now manager of the Texrope Drive section.

A-C has redesigned its large end-shield bearing synchronous and wound-rotor in induction motors of more than four poles to utilize the same capsule bearing and cast end-shield construction featured in its standard large squirrel-cage induction motor line.

CYANAMID

American Cyanamid Co., New York, N. Y., recently dedicated its new Fortier plant near New Orleans, La. The plant will produce acrylonitrile and other chemicals from natural gas.

Owen M. Cornell has been appointed west coast manager of Cyanamid's Paper Chemicals Department.

NATIONAL STARCH

National Starch Products, Inc., New York, N. Y., has established scholarships of $2000 each at Columbia University, Case Institute of Technology, University of Nebraska, North Carolina State College, Syracuse University (N. Y. State School of Forestry), and Rutgers University.

The National Adhesives Division has developed a new remoistening resin emulsion for envelope flap sealing. Designated Enva-Lok, the new adhesive is claimed to give an instant safety seal on all types of envelope stock, including rag bond and kraft.

Robert DeWolfe has been appointed supervisor of New York sales for National Starch.

NATIONAL ANILINE

The National Aniline Div. of Allied Dye & Chemical Corp., New York, N. Y., is producing a new liquid form of Nacconol, designated Nacconol SL.

ERKOTE

Earl Paint Corp., 240 Genesee St., Utica, N. Y., has issued a bulletin (No. 15) on Erkote 6 × Weather Barrier, a mastic designed for use over all types of thermal insulation on heated equipment, where a breathing type of mastic is desirable.

O. M. Cornell, American Cyanamid Co.

Frank Greenwall, National Starch Products Inc.

CARPENTER

Robert F. Elmiger has been appointed sales promotion manager of The Carpenter Steel Co.'s Alloy Tube Division, Union, N. J.

PARSONS AND WHITTEMORE

John N. McGovern, formerly chief of the pulping section, Pulp and Paper Div., Forest Products Laboratory, Madison, Wis., has joined the executive staff of Parsons and Whittemore, Inc., New York, N. Y.

ROSS

J. O. Ross Engineering Corp.'s Los Angeles office has been moved to the new Ross plant at 6417 Bandini Blvd., Los Angeles 22, Calif.

PERMUTIT

The Permutit Co., 330 W. 42nd St., New York, N. Y., has published a new edition of its Water Conditioning Data Book, No. 2478A.

LANGSTON

Samuel M. Langston Co., Camden, N. J., has increased by 50% its capacity for cutting corrugating rolls, by the addition

One of three heavy duty planer-millers, recently installed in the new plant of Samuel Langston Co., Camden, N. J., making a total of nine now used to cut flutes in Langston corrugating rolls. The company also has doubled roll lapping capacity by the addition of a new lapping machine

of three more Ingersoll planer-millers, making a total of nine in the corrugating roll dept.

CRANE

Crane Co., Chicago, Ill., will celebrate its 100th anniversary on July 4, 1955. The occasion will be celebrated at the various offices and plants of the company during the entire calendar year of 1955.

GRAVER

Harold R. Fosnot has been appointed sales manager of the Graver Water Conditioning Co., New York, N. Y.

ARCCO

Robert E. Munsell has been named technical representative in New England for American Resinous Chemicals Corp., Peabody, Mass.

BULKLEY DUNTON

The Pasadena, Calif., Office of Bulkley Dunton Processes, Inc., is now under the direction of C. P. Ryan and D. Adler.

N. J. Connor, Babcock & Wilcox Co.

A. J. Cirrito, Rice Barton Corp.

B & W

N. J. Connor has been appointed manager of the New York district office of the Babcock & Wilcox Co., replacing H. E. Martin, who has resigned.

RICE BARTON

Anthony J. Cirrito has been appointed assistant to the president, in connection with advanced development and research, of the Rice Barton Corp., Worcester, Mass.

RHODIA

Rhodia, Inc., 230 Park Ave., New York, N. Y., which recently acquired the Industrial Alamask Reodorant Div. of E. I. du Pont de Nemours & Co., Wilmington, Del., has established an engineering service section within the division. Chief of the section is H. C. Nichols. Also associated with the section are Stanley A. Dunn and David Bowlus. Sales management is under Edward A. Bush.

OBITUARIES

Henri Breton

Henry Breton, general manager of S/A Papeteries Aubry, president and general manager of S/A L'Ondulium and S/A Sofina, died on May 15, 1954, in his sixty-seventh year at Croisset les Rouen, France.

Mr. Breton became a member of the Technical Association of the Pulp and Paper Industry in 1933. He was the corporate representative of Papeteries Aubry since 1933 and took an active interest in TAPPI over the years.

Maynard J. Cusack

Maynard J. Cusack, vice-president of the Shawano Paper Mills, Shawano, Wis., died on April 17, 1954, following a three-month illness.

Mr. Cusack was born in Lyndon, Wis., on April 26, 1906. Prior to joining the Shawano Paper Mills he was Chicago sales manager for the Riegel Paper Corp. with whom he was associated for more than 20 years.

During World War II Mr. Cusack was given a special award for research and development work in the Army's food program.

Mr. Cusack joined the Technical Association of the Pulp and Paper Industry in 1948.

TAPPI Plastics Committee

Fibrous Materials for Laminated Products Subcommittee

A meeting of the above subcommittee took place at TAPPI Headquarters, 155 E. 44th St., New York 17, N. Y., on May 25, 1954, at 10:00 a.m. The following attended:

Paul M. Goodloe, Brown Co. (Chairman)
V. A. Belcher, New Jersey Zinc Co.
J. F. Blais, Fitchburg Paper Co.
J. S. Bowen, Lunn Laminates
R. H. Doughty, Fitchburg Paper Co.
J. J. Forsythe, International Paper Co.
D. G. Higgins, John Waldron Co.
R. T. Nazzaro, Westfield River Paper Co. (Chairman, Plastics Committee)
T. M. O'Neil, Masonite Corp.
H. G. Rappolt, J. O. Ross Engineering Corp.
W. E. Sanders, Panelyte Div., St. Regis Paper Co.
G. R. Shaw, Taylor Fibre Co.
C. J. Straka, Westinghouse
C. J. Waechter, John Waldron Corp.
F. B. Wardwell, Brown Co.
V. T. Stannett, College of Forestry (Secretary)

The minutes of the previous meeting were read and approved It was emphasized that any fibrous material which could be made on a paper machine including glass and textile fibers could properly come within the scope of the subcommittee. The chairman announced that a meeting of laminators would be held in the Cleveland Hotel, Cleveland, Ohio, at 9:30 a.m., Friday, June 11, and urged all interested members to attend.

The unavoidable absence of H. Spencer (Knowlton Bros.) prevented a report and discussion on possible research and work projects. This will be presented at the next meeting.

The secretary then reported on the results of the survey on current test procedures, about 20 companies replied of which eight reported on their current methods and difficulties. The following tests on laminating papers were currently used: caliper, basis weight, porosity, burst, tensile and oil (usually castor oil) and water absorption tests. The two latter tests were generally regarded as unsatisfactory as given a measure of resin saturation rate and capacity.

After considerable discussion it was agreed that to use a resin solution itself as the absorption or penetration test fluid would be preferable. However, this had not been thought practicable owing to their lack of stability and reproducibility. Finally it was agreed that a dry powdered resin would be sufficiently stable and could be made up into a solution of standard viscosity or concentration before using for the saturation test. The importance of (1) rate of absorption (2) amount of absorption and (3) distribution of the resin was emphasized. The last was more difficult to specify and would need considerable study. However, the first two could be measured and the committee agreed to investigate the reproducibility and value of such a method using a melamine and a phenolic resin as a beginning. It was suggested that a standard paper such as filter paper could be used and a standard resin and procedure. The following companies agreed to participate in the tests: Brown Co., Westinghouse, Panelyte (St. Regis), Fitchburg Paper, International Paper Co., and Taylor Fibre. The secretary was asked to serve as chairman of the test committee and to extend an invitation to industry to participate in these and other investigations. The scope of the work would be limited initially to high pressure paper based laminates. The relevant A.S.T.M. committee would also be kept fully informed and asked to comment. The chairman emphasized that the committee was anxious to avoid any duplication of work by other organizations.

The industry would also be invited to name one representative to the committee to receive correspondence, etc., although any number could attend meetings.

One paper on "New Developments in the Manufacture of Organic and Inorganic Synthetic Fiber Paper," by H. F. Arledter, Hurlbut Paper Co., was submitted for presentation at the next TAPPI plastics conference and was unanimously accepted.

The next meeting of the committee was scheduled for Wednesday, Sept. 15, 1954, at 10:00 a.m., TAPPI, 155 E. 44th St., New York 17, N. Y.

V. T. Stannett, *Secretary*
TAPPI Plastics Committee

Pulp Testing Committee

A meeting of the Pulp Testing Committee was held on May 21, 1954, in the Gearhart Hotel, Gearhart, Ore.

Approval was given to the revision of TAPPI Standard, T 205 m-53 (Forming Handsheets for Physical Tests of Pulp). The revision pertains to wording in which one of the objects of the method is "to duplicate as far as possible. . . the average conditions under which pulp is commercially made into paper." The revised standard will be forwarded for adoption by TAPPI.

It was also decided to refer the matter of TAPPI furnishing aluminum foil, which could be used as a check of the bursting strength (mullen) tester, to the Paper Testing Committee. It was agreed that the experiences of our members would be included in this letter.

Chairman Caskey announced that the Testing Conference will be held in Dayton, Ohio, on October 6 to 8. All members of the Pulp Testing Committee are urged to attend. Further, each member is requested to write Chairman Caskey pertaining any testing procedure that possibly could be used on the program.

The problem of establishing a procedure for determining stock consistency has been taken over by F. A. "Del" Del-Forge of the Robert Gair Co., Uncasville, Conn. It was also announced that ideas have been expressed by various people about stock consistency in the "Letters to the Editor" section of the April issue of *Tappi*. Some of the members pointed out that the ideas expressed in these letters should be seriously considered in our efforts to establish this procedure.

The meeting was adjourned with the announcement that this was the last one until Fall.

Frank E. Caskey, *Chairman*

Fourth Testing Conference

Dayton-Biltmore Hotel
Dayton, Ohio

October 6–8, 1954

LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel, and Events

Southeastern

The fifth and final program of the fiscal year of Southeastern Section of TAPPI was held at the DeSoto Hotel, Savannah, Ga., May 14, 1954. About 200 members and guests were registered for the meeting.

A meeting of the Executive Committee was convened at 4:00 p.m. to review the past year's work and to make preliminary plans for the next year.

The social hour was at 6:15 p.m. and dinner was at 7:00 p.m.

Mr. Pineo, chairman of the local section, was in charge of the general session.

R. G. Macdonald, Secretary-Treasurer of National TAPPI, was presented to the group and made some interesting comments on the Local Section and on National TAPPI.

Mr. Pineo turned the meeting over to J. R. Lientz to conduct the election of officers for the ensuing year. The report of the nominating committee was read and the following slate of officers were elected or appointed: M. B. Pineo, chairman; C. N. Rogers, vice-chairman; W. C. Chapman, program chairman; R. A. Flick, corresponding secretary; W. M. Ackerman, local arrangements chairman; and C. L. Smith, recording secretary.

Claude Adams welcomed the group on behalf of the host mill, Southern Paperboard Corp. Mr. Adams also described the operation at Southern Paperboard and explained various phases of their expansion program. He extended a cordial invitation to all members and guests to visit the mill on Saturday from 8:30 to 11:00 a.m.

Mr. Rogers was in charge of the program during which four prepared papers were presented.

J. B. Bain, research and technical director of the Glidden Co., Naval Stores Div., Jacksonville, discussed "By-Products of the Pulping Industry."

It was obvious that the entire membership of the society was much impressed by the presentation of Mr. Bain's paper; both as to its mode of presentation and by its context. We were all witnesses to an accounting of the handling of the by-product picture by the various mills and the prediction of "things to come" in this field. The possibilities in this field have not even been scratched yet. We were made to feel that the processors of the mill by-products were not a separate industry but intimately tied in with the economics of our own industry. It seems important that we recognize the necessity of developing this group that use about every constituent of the tree except the fiber and integrate ourselves with them. To do that means that we must realize that the by-products must not only be given more consideration, but that the factors which cause wide variation in the quality of the by-products must be studied and remedied where possible. The day may come when pulp mills may be able to classify their by-products as some of their principal production items.

Some of the by-product materials which are obtained from the various pulping operations are as follows: turpentine, tall oil, alcohol (acid process), yeast (acid process), rosin, black liquor soap, flavors—vanillin (acid process), cymene (acid process), and lignin.

Some of the products produced from these by-products are: alpha pinene, beta pinene, mersene, camphor oil, cedar oil, ethylalcohol (fermented wood sugars), and plastics from lignin.

Mr. Bain's report pointed out that one of the reasons for reluctance to use the mill by-products in more diverse fields was the serious degree of contamination found in the by-products. The cost of purifying raises too great a competitive barrier.

Two of the by-products of considerable importance to processors were discussed at some length by Mr. Bain. These were tall oil and turpentine. He covered some interesting points in their purification as well as some world-wide statistics in their production.

In summing up his talk Mr. Bain said:

"Over the past ten years knowledge on the utilization of crude sulphate turpentine has reached the point where the mills can at present count on disposing of this by-product profitably and little or no crude sulphate turpentine need by burned.

"Utilization of tall oils is not quite so advanced but is progressing rapidly as more uses are developed and as it is being converted to higher quality products possessing greater use and flexibility.

"Other by-products of wood pulping are being investigated by numerous organizations and eventually some of these will become important as their manufacture becomes economically feasible."

W. S. Cummings and C. L. Smith of National Container Corp. gave a short paper on their operating experiences with polystyrene ion exchange resins for softening water for boiler use.

A preliminary survey of chip size prepared by Messrs. Kemp, Sproull, and Stevens, all of Herty Lab., was presented by Mr. Kemp. He pointed out that the entrance into commerce of wood chips from sawmill waste brings recognition of a need for testing methods which might form a basis for specifications. An attempt has been made to develop such methods. Although the results have not been entirely satisfactory, the data for the sawmill chips do fall within the range of variation of those obtained on chips from an equal number of different pulp mills using the same kind of wood.

Hope was expressed that presentation of these data might stimulate interest and lead to ultimate development of satisfactory chip evaluation methods.

G. W. E. Nicholson, vice-president, Union Bag & Paper Corp., gave a very interesting talk on "Ideas on Management-Employee Relations" (see the July, 1954 issue of *Tappi*). He dealt largely with the value of exercising proper human relations when handling employees. Since attitudes and management methods are changing, he recommended a review of the methods at least every 5 years. Since we can't stand still, but must go either forward or backward, we must give more attention to management and employees working together internally. Top executives have to recognize this. Problems must be handled efficiently and properly by thinking first, then acting. Management should inspire our help to do their best and to use their heads. Mr. Nicholson further pointed out that supervisors are to lead in carrying out orders as well as issue orders. Human relations is an essential part of industry. By means of them, employees can tie in more closely with company programs.

The importance of the foreman cannot be overemphasized. The following qualifications necessary for supervisors were given: (1) health, (2) integrity, (3) intelligence, (4) personality, (5) leadership ability, (6) friendliness, (7) education, (8)

ability to get things done, (9) potentialities for the future, and, most important, (10) company loyalty.

It is important that management be interested in every employee and show it. This is very interesting as well as effective. An employee is proud to be recognized. Give the men a chance to develop; compliment them for their good work. If it isn't good explain how and why it should be different. Explain the need for quality.

Recognition should be given employees by advising them of changes, making study courses, promotions, and opportunities for self betterment available.

Mr. Nicholson concluded his remarks by emphasizing that people are our most important and valuable asset.

C. L. Smith, *Recording Secretary*

Water Softening Experience with Polystyrene Ion Exchange Resins

W. S. Cummings and C. L. Smith

This paper presents no earth-shaking findings from the inner sanctum of a research or development laboratory. A small amount of lab work, however, was required, and most of the so-called experimental work has and is being done on a mill scale. This hasn't always turned out as we thought it should to give a paper of the most interesting type.

We are presenting some of the results of our everyday experience with high capacity polystyrene ion exchange resins as used in softening water for boiler use, and it is hoped they will be of value. We are quite sure a history of this type experience would have been of great help to us had we heard it several months ago.

In January, 1947, we installed a low capacity zeolite for boiler water softening. This material required pH adjustment with sulphuric acid, and we had no end of trouble trying to operate this system. Actually the material withstood alkaline water better than the supplier claimed because we put it to the test by not being able to feed acid properly.

To end all our troubles—we thought—including the riddance of the acid feeding system, we replaced all our old zeolite with polystyrene ion exchange material in March, 1951.

We had trouble getting full capacity from these softeners at first, due to improper salting plus miscellaneous operating troubles. By mid 1951 we were obtaining staisfactory operation—treating about 500,000 gal. water per regeneration with an average hardness of 2.4 grains per gal. This is about what we could expect—1200 kilograins, total or about 23 kilograins per cu. ft. resin. Salt use was 8 to 9 lb. per cu. ft. resin.

The raw water for the above treatment was obtained from deep wells having a H_2S content of about 1.8 p.p.m. as it came from the ground. Some aeration and 8 to 10 min. retention time in a small reservoir reduced this to a few tenths parts per million.

Treatment before the zeolites is cold soda ash lime in an Accelator. Hardness is reduced from 15 to 2.5 grains per gal.

Fairly satisfactory operation was obtained from this high capacity resin through September, 1952.

On September 28, we began using water from our no. 1 well which had been recently enlarged to take care of all our requirements. This water reached the primary treatment with no aeration. The chief difference in analysis was the higher sulphide content—1.8 p.p.m. as compared to 0.1 to 0.3 p.p.m. before the changeover. The only immediate effect was a considerable increase in chlorine demand.

In the first 2 weeks of October, however, the capacity dropped to a little below 900,000 grains (compared to 1,150,000 grains). By October 26, the capacity had dropped to a little below 400,000 grains. The situation was getting serious as considerable outage time was necessary, to say nothing of the additional salt being used.

We became suspicious at this time that sulphides in the water were doing something to the resin—either directly or indirectly. Nothing in the literature, however, could be found to confirm this. The experts were not sure that sulphides wouldn't hurt but they could see no reason why they should.

In late November, 1952, the beds were given an acid wash with 10% HCl inhibited with 2% formaldehyde. This gave temporary relief. December figures showed normal or nearly normal capacity.

One month later (January, 1953) capacity had dropped to 800,000 grains and 2 months later (February, 1953) capacity was 650,000 grains.

At this time, and with no further acid washing, we switched back to our original water supply with a H_2S content of 0.1 to 0.3 p.p.m. Several such shifts of water supply convinced us that it would be better to stick with the low sulphide water.

We would like to point out that we were aware of the probability of improper filter backwashing and contamination of the softeners from this source. This was investigated and some improvements were made.

The striking thing about the whole situation, however, was the seeming correlation of loss of capacity with sulphide water. We thought it was proved beyond a doubt.

For the next 6 months (April to October, 1953) we had good operation with normal softening capacities on low sulphide water, but wouldn't you know it—just about the time we thought we had it licked—capacity dropped to 1,000,000 grains per gal. in October, 850,000 grains per gal. in November, and 600,000 grains per gal. in December—and this with low sulphide water!

At this time, we decided to give the softeners a strong treatment with chlorine. Our thinking was that if bacterial growth was present, chlorine might destroy it and enable our beds to regain full capacity. Therefore, chlorinated water was passed to the softeners, gradually increasing the strength until we reached 35 p.p.m. At that time we closed all valves and let the water remain in contact with the resin for an hour. The chlorine content after this period was 12 p.p.m. The softener was then backwashed and returned to service. We received no apparent benefit from this treatment.

Another angle of approach in attempting to explain bacteria contamination, if any, was an investigation of *Beggiatoa*.

Several months ago we had the opportunity of reviewing Rayonier's water treating experience with Mr. Scofield and Mr. Lewis. They pointed out the benefit that *Beggiatoa* had been to them in reducing H_2S. Our spray tower experiments, not covered in this report, also showed how it serves as a means of reducing H_2S. We thought that perhaps *Beggiatoa* was growing inside the bed. Subsequent tests, however, indicated to us that it would not grow at the pH of 10.5 present in the softeners. It grows readily, however, in the raw water before treatment.

In January of this year, we were still in bad shape with respect to softener capacity.

Samples of the bed were evaluated in our own laboratory. Additional samples were forwarded to a water consulting firm and to the manufacturer of the resin.

Our own lab results showed that whatever the total cause of reduced capacity, a strong acid wash restored the resin to practically full strength.

Without waiting for reports on the samples sent to the experts, we decided to give the beds an acid wash to end all acid washes—either ruin or cure (we had replacement in case it ruined).

To the observer or curiosity seeker, we were using 10% HCl with 2% formaldehyde. I'll tell you confidentially we had it stronger than that. We really jolted it. Air agitation of the bed helped cleanse it throughout.

W. S. Cummings and C. L. Smith, National Container Corp., Jacksonville, Fla.

These beds were returned to service on low sulphide water and gave excellent results.

Several weeks ago we shifted water supply again to high sulphide water to see what would happen—so far there has been no noticeable change. We plan to continue in this way indefinitely to see if we again experience a loss in capacity. We are still seeking a positive answer as to whether or not, sulphides will or have caused a loss in softener capacity.

In closing we should like to point out the findings on the samples sent out:

One report stated: (1) The sample (as received) contained a white insoluble material and had a strong odor of hydrogen sulphide. (2) The white precipitate dissolved in hydrochloric acid—a mixture of $CaCO_3$ and $MgCO_3$. (3) The sample was fouled with insoluble carbonates and bacterial growth.

The other report stated: (1) The mineral was reduced in capacity due to a coating consisting of a complex formation of iron and phosphate.

Table II. Comparison of Results of Fractionations Using Round Holes Versus Square Holes: Pulp Mill C

Equipment →	*Williams classifier*		*Herty pilot shaker screen*	*Syntron*	
Holes → *Fraction*	*Round* %	*Square* %	*Square mesh* %	*Square* %	*Round* %
On 1 in.	0.4	2.0			
On 3/4 in.	3.4	2.5			
Total	3.8	4.5	4.7	2.5	9.4
On 1/2 in.	19.6	23.0			
On 1/4 in.	48.5				
Through 3/4 on 1/4 in.	(68.1)			73.3	75.5
Through 3/4 on 1/8 in.	24.0	70.5			
Through 3/4 on 1/8 in.	92.1	93.5	90.0		
Fines	4.1–4.1	2.0–2.0	5.3	24.2	15.1

A Preliminary Survey of Chip Size

George N. Kemp, Reavis C. Sproull, and R. H. Stevens

Of the many current trends and modern developments in the manufacturing industries dependent upon wood, none is so pregnant with possibilities for benefit to the forest owner, tree farmer, and wood user, as the debarking of whole logs. Whether these go to sawmills or are cut to pulpwood on the wood lot matters little. With bark removed sawmill slabs or pulpwood bolts are ready for the chipper. If this be located at a sawmill or wood assembly point, chips can be transported in bulk by rail or truck to pulp mills wherever economic conditions may permit.

Wood in chip form as an article of commerce requires suitable testing methods to assure uniformity, facilitate contract specifications, and control deliveries. Recently the Herty Laboratory was called upon to appraise chips from wood waste. This led to investigation of screening methods. Considerable divergence was found in chip screen equipment in different mills and the character of chips produced.

Naturally first consideration was given to TAPPI Standard T 16 m-50. This "is useful in controlling various operations in the preparation of chips, such as determining when to sharpen chipper knives and the maintenance of efficient opera-

George N. Kemp, Reavis C. Sproull, and R. H. Stevens, Herty Foundation Laboratory, Savannah, Ga.

Table I. Results of Various Screen Tests on Chips from Various

	Sawmill no. 1 Pine		*Sawmill no. 2* Pine		*Sawmill no. 3* Pine	*Pulp mill A* Pine	*Pulp mill B* Pine
	Unscreened	*Screened*	*Unscreened*	*Screened*	*screened*	*screened*	*screened*
Moisture, %	54.0	52.0	45.8	45.7	54.0	55.0	23.2
Pounds per cubic foot	26.0	24.5	22.0	23.8	26.0	24.5	19.3
Pounds per cubic foot, moisture-free	12.0	11.8	11.9	12.9	12.0	11.0	14.8
					Fractionation on Herty Pilot Shaker Screen		
On 3/4 in., %	19.8	21.8	22.3	17.3	12.8	18.8	3.5
Through 3/4 on 1/8 in.	76.9	77.1	76.1	81.2	85.1	79.0	95.5
Through 1/8 in.	3.3	1.1	1.6	1.5	2.1	2.2	1.0
					Syntron Fractionations		
Square holes →	a b	a b	a b	a b	a b	a b	a b
On 3/4 in., %							
(1)	12.2 14.0	16.1 13.4	31.1 25.9	35.6 37.9	24.7 27.7	14.2 13.7	4.3 4.6
(2)	8.1 9.0	14.0 12.9	14.5 14.1	21.4 19.5	19.2 20.8	19.8 22.1	5.7 5.7
Av.	10.8	14.1	21.4	28.6	23.1	17.5	5.1
Through 3/4 in. on 1/4 in., %							
(1)	72.7 69.9	70.3 75.3	63.3 68.1	58.5 56.5	67.8 64.7	76.5 77.0	85.6 85.4
(2)	77.1 75.8	75.5 76.4	77.8 77.9	71.8 73.5	75.1 73.7	70.1 67.6	83.2 82.3
Av.	73.9	74.4	71.3	65.1	70.3	72.8	84.1
Through 1/4 in., %							
(1)	15.1 16.1	13.6 11.3	5.6 6.0	5.9 5.6	7.5 7.6	9.3 9.3	10.1 10.0
(2)	14.8 15.2	10.5 10.7	7.7 8.0	6.8 7.0	5.7 5.5	10.1 10.1	11.1 12.0
Av.	15.3	11.5	6.8	6.3	6.6	9.7	10.8
Round holes →	a b	a b	a b	a b	a b	a b	a b
On 3/4 in., %							
(1)	26.0 26.2	32.9 34.0	54.3 57.3	57.6 58.9	42.8 41.1	48.0 45.3	20.7 20.7
(2)	26.0 26.9	31.0 29.9	37.8 31.5	37.6 38.3	45.2 47.1	56.3 49.4	21.4 22.0
Av.	26.0	32.0	45.2	48.1	44.1	49.8	21.2
Through 3/4 in. on 1/4 in., %							
(1)	64.8 64.9	60.9 59.5	42.8 39.9	39.9 38.5	53.8 55.4	46.1 48.3	74.8 74.8
(2)	64.8 64.7	62.9 64.5	58.3 64.9	58.5 57.9	51.1 49.1	37.0 44.0	73.4 71.6
Av.	64.8	62.0	51.5	48.7	52.3	43.8	73.6
Through 1/4 in., %							
(1)	9.2 8.9	6.2 6.5	2.9 2.8	2.5 2.6	3.4 3.5	5.9 6.4	4.5 4.5
(2)	9.2 9.4	6.1 5.6	3.9 3.6	3.9 3.8	3.7 3.8	6.7 6.6	5.2 6.4
Av.	9.2	6.1	3.3	3.2	3.6	6.4	5.2
					Fractionation on Williams Chip Classifier		
On 1 in., %	25.6	16.1	13.5	8.3			0.9
Through 1-in. on 3/4 in. %	19.4	21.0	16.4	15.5			9.2
Through 3/4 in. on 1/2 in. %	26.3	32.5	30.0	31.1			32.2
Through 1/2 in. on 1/4 in. %	23.0	26.5	32.6	36.0			51.0
Through 1/4 in. on 1/8 in. %	4.9	3.7	6.6	8.7			6.4
Through 1/8 in. %	0.8	0.2	0.9	0.4			0.3

Table III. Average Middle Fractions

Wood → / Source → / Screened →	Pine: Sawmill no. 1 No	Pine: Sawmill no. 1 Yes	Pine: Sawmill no. 2 No	Pine: Sawmill no. 2 Yes	Pine: Pulp mill B Yes	Pine: Pulp mill C No	Hardwood: Pulp mill D No	Hardwood: Pulp mill E No	Hardwood: Herty lab. No
Size: Through 3/4 in.; Retained on 1/8 in.									
Herty pilot screen, %	76.9	77.1	76.1	81.2	95.5	90.0	78.3	83.4	93.2
Williams round hole	54.2	62.7	69.2	75.8	89.6	92.1	62.3	88.3	86.4
Williams square mesh	...	...	...	...	...	93.5	...	...	...
Size: Through 3/4 in.; Retained in 1/4 in.									
Syntrol square holes, %	73.9	74.4	71.8	65.1	84.1	73.3	75.6	70.8	88.7
Syntrol round holes	65.3	62.0	51.5	48.7	73.6	75.5	50.6	72.1	69.1

tion of rechippers, chip breakers, and chip screens, thereby maintaining the uniformity of size distribution. . ." The method specifies, "The screening surface of each sieve shall be a round-hole perforated plate conforming to the Standard Specifications for Sieves for Testing Purposes of the American Society for Testing Materials." There follow in minute detail specifications covering plate thickness, diameter of holes, spacing of openings, shaking or vibrating mechanism, time control, and quantity to use. This, "Shall not exceed a volume equivalent to 1/4 cu. ft. per sq. ft. of effective screening area, nor less than 3/4 cu. ft. in total volume." Strangely, however, nothing is said about rate of vibration, or shaking, nor about the length of stroke.

Lacking apparatus conforming to T 16 m-50 a locally built shaker screen already in use at the Herty pilot plant was employed. It consists of an angle iron frame which supports a shaker frame with two sieves.: top 46 by 77-in. Tyler 3/4 by 3/4-in. mesh; bottom 46 by 69-in. Tyler 1/8 by 1/8-in. mesh. The shaker frame rests on four 4-in. diam. steel rollers. These run in 8-in. channel irons turned edgewise to form the sides of the supporting frame. The shake, with 1-in. stroke, is actuated by a mechanism consisting of: connecting rod (5/8 by 10 in. long) Fafnir cam (5 in. diam.) on 1 3/8-in. countershaft with 18-in. diam. pulley driven by 1 3/4-in. wide cog belt from a Llewellen variable speed pulley (size 228) mounted on a 220-v. single-phase 1710 r.p.m. 1-hp. G.E. motor. Usual operating speed about 225 strokes per min.; duration 5 min.; quantity of chips 1 cu. ft.—this is 0.04 cu. ft. per sq. ft. of screening area.

Further smaller scale tests were made in a Syntron sieve shaker. This equipment, by the Syntron Co., Homer City. Pa., employs the familiar magnetic vibrator to shake a nest of 8-in. diam. by 2 in. deep brass sieves. Four A.S.T.M. stone sieves and screens were employed for the chips, viz., two sieves with 3/4 and 1/4-in., respectively, *square* holes and two screens with 3/4 and 1/4-in., respectively, *round* holes. The 1/4 in. is the smallest available in standard size.

The quantity of chips used was enough to fill the top sieve to a depth of 1/4 in. This is 0.036 cu. ft. The sieve area (8 in. diam.) is 50 sq. in. or 0.347 sq. ft. Therefore the chip quantity was approximately 0.1 cu. ft. per square foot of screen area. The weight ranged from 250 to 350 grams, average about 300 grams.

Through the courtesy of a good neighbor we were permitted to use a Williams chip classifier, which conforms to T 16 m-50, and the results obtained for nine of the lots of chips studied are included in Table 1*.

Also one of the cooperating pulp mills very kindly supplied data on their chips obtained with a Williams chip classifier fitted with *square* mesh sieves instead of round hole screens. These results are given in Table II in parallel with the *round* hole Williams screens, Syntron tests (averages only) and the Herty pilot shaker screen.

Sources

Pulp mill C Pine unscreened	Pulp mill D Hardwood unscreened	Pulp mill E Hardwood unscreened	Herty lab. Hardwood unscreened
43.6	42.8	32.5	46.1
26.0	20.0	22.0	22.0
14.7	13.3	14.7	13.0
4.7	20.4	9.6	2.1
90.0	78.3	83.4	93.2
5.3	1.3	7.0	0.7
a b	a b	a b	a b
0.3 0.3	18.6 17.7	11.9 12.2	10.7 7.0
4.8 4.4	22.6 20.3	26.0 25.9	8.4 11.7
2.5	19.8	19.0	9.5
73.8 74.5	76.6 77.8	76.4 74.5	87.0 90.7
72.0 72.8	72.9 75.1	66.3 65.9	90.4 86.8
73.3	75.6	70.8	88.7
25.9 25.2	4.8 4.5	11.7 13.3	2.3 2.3
23.2 22.8	4.5 4.6	7.7 8.2	1.2 1.5
24.2	4.6	10.2	1.8
a b	a b	a b	a b
7.0 6.7	45.8 47.6	12.3 11.6	25.5 25.8
12.0 11.8	47.3 46.7	21.9 21.3	36.9 32.3
9.4	46.8	16.8	30.1
77.0 76.8	51.5 49.6	73.8 76.1	73.6 73.1
73.8 74.5	50.3 50.9	68.5 70.1	62.6 67.1
75.5	50.6	72.1	69.1
16.0 16.5	2.7 2.8	13.9 12.3	0.9 1.1
14.2 13.7	2.4 2.4	9.6 8.6	0.5 0.6
15.1	2.6	11.1	0.8
0.4	14.3	1.7	3.3
3.4	22.8	6.3	10.2
19.6	36.9	39.4	58.8
48.5	21.4	38.7	24.4
24.0	4.0	10.2	3.2
4.1	0.6	3.7	0.1

PROCEDURE

The chips as received were mixed well, quartered down to a little more than 1 cu. ft., a cubic foot measure was filled weighed, and then screened on the Herty "pilot screen." This was repeated with several cubic foot batches and the results averaged. Some of the quartered chips were employed for overdrying, Syntron sieving, and the Williams chip classification.

Syntron tests were made in duplicate on two separate samples for each lot studied. In Table I all four results for both square and round sieves are given to show the variations. Averages of the four are given also.

CONCLUSIONS

1. The chip densities, in pounds per cubic foot moisture-free, for the sawmill chips fall within the range of densities for pulp mill chips.

2. Generally the chip density is greater when the large chip fraction ("on 3/4-in.") from the Herty pilot screen is smaller.

3. Generally the middle fractions (through 3/4 in.) of the Herty pilot screen agree better with those from the Syntron

* The "Herty Lab." chips were from a gum veneer core chipped on the Herty 48-in., four-knife Carthage chipper.

square hole sieves than with the Syntron *round* hole screens. As is to be expected the latter agree better with the Williams *round* hole screens.

4. The best chips have more than 90% of middle fraction.

Maine-New Hampshire

The Maine-New Hampshire Section of TAPPI held its annual meeting and Spring technical session at the Marshall House, York Harbor, Me., on June 18 and 19, 1954. Featured on the meeting program Friday were technical papers on pulping methods and problems of the pulp mill followed Saturday by a panel discussion on the general subject, "Recent Advances in Pulping Technique." Also on the program were the annual business meeting and election of the section officers and executive committee, a bridge and canasta tournament and historical tour of York especially for the ladies and outdoor clambake on the shore, golf tournament, deep sea fishing, and other recreational activities.

Annual Business Meeting

The annual business meeting was held Friday, June 18, with Chairman Thomas presiding. In addition to routine business and reports a change in the by-laws was made whereby the chairman, upon retiring, automatically becomes a member of the executive committee for a 2-year term. Officers and executive committee members were elected for 1954–55 with the following results: Chairman, Arthur E. Jones, Oxford Paper Co., Rumford, Me.; Vice-Chairman, Fredrick N. Sprague, St. Regis Paper Co., Bucksport, Me.; Secretary-Treasurer, H. E. Pratt, Pejepscot Paper Div., Brunswick, Me.; Executive Committee for 1 year, Albert E. Bachmann, Missisquoi Corp., Sheldon Springs, Vt.; Wadsworth L. Hinds, Keyes Fibre Co., Waterville, Me.; J. F. Wright, National Aniline Div., Boston, Mass.; for 2 years, J. H. Heuer, Great Northern Paper Co., Millinocket, Me.; Henry S. Hooper, Penobscot Chemical Fibre Co., Great Works, Me.; Roland Martin, Fraser Paper, Ltd., Madawaska, Me.; for 3 years, C. T. Backus, Eastern Corp., Bangor, Me.; Andrew C. Chase, University of Maine, Orono, Me.; Edward N. Poor, Hudson Pulp & Paper Corp., Augusta, Me.

W. L. Hinds, *Public Relations Chairman*

Introductory Remarks

A. E. Jones

As you all probably know, our pulp and paper industry is the most important of the wood-using industries in the Northeast and that in the whole country it ranks 5th among prime manufacturing industries in value of product. This value in 1953 amounted to about 9 billion dollars which was up 9% from 1952. Perhaps some of you are not aware that our industry employs more than 440 thousand production workers earning in excess of $1,680,000 in 1953 and that Maine ranks third in this respect behind only Wisconsin and and New York and that New Hampshire stands sixteenth. Likewise, how many of you have stopped to realize that more than nine tenths of all the paper is made from wood pulp and that about 14% of the total volume of wood harvested currently from American forests is used for the production of pulp? Last year, this amounted to a consumption of over 28,000,000 cords of wood and from this wood 17½ million tons of pulp were produced in the United States and both were up over 6% from the previous year. It has been estimated, too, that by 1960 over 30,000,000 cords of wood will be required.

It has been difficult to obtain similar figures for Maine, New Hampshire, and Vermont but for illustration just under 4,000,000 cords were used last year by concerns operating pulp mills in the Northeast. This figure is higher than for all previous years except 1951 and 1952. Perhaps our speaker on the program, Mr. Jensen, will be able to give us more information onthe actual amount of wood consumed in these three states.

A. E. Jones, Oxford Paper Co.

From the pulp standpoint, New England produces 10% of the total wood pulp made in the United States and Maine makes 7.9% of the total. Comparable figures for sulphite pulp are 19 and 17.2%, respectively. Similar data for New Hampshire and Vermont and for the other grades of pulp are not readily available but New England as a whole accounts for 29 % of the total soda pulp produced and 28% of the groundwood. It is not unreasonable to assume that the three northern states produce the bulk of this wood pulp and that Maine is the largest producer of the three.

It is interesting to note the ratio between the different kinds of pulp and the trend over the years in this ratio. Of the total wood pulp produced last year, sulphite accounted for 13.2%, sulphate 53.8, soda 2.4, groundwood 13.6, semichemical 5.9, special alpha and dissolving grades 3.9, and other made up of screenings, defibered and exploded wood 7.2%. Over the years, the outstanding trend has been for a steady decrease in the sulphite and groundwood and a corresponding increase in sulphate pulp. Soda has shown a smaller but still steady decrease and semichemical has been increasing.

Likewise, it may interest you to know that in Maine, New Hampshire, and Vermont there are 60 paper mills and 36 pulp mills. Running through them quickly in these three states there are 16 groundwood mills, 14 sulphite, 2 soda, 2 sulphate, 1 semichemical and 1 other, whatever that is.

It is believed that from the foregoing facts and figures you can readily realize the importance of our forests and wood pulping to all of us here today, and therefore we have selected as the theme for our technical program "Recent Advances in Pulping Techniques."

It was thought that an excellent introduction to the papers this afternoon on pulping would be a talk on the pulpwood part of the picture in the Northeast and especially as it applied to Maine, New Hampshire, and Vermont. Also, it was felt that information on the current supply of softwood and hardwood and what we can expect for a future supply based on growth and drainage rates would be of interest. In addition, no doubt some of us would like to learn more about what we can look for insofar as species distribution in future years particularly as it will be influenced by regeneration, forest practices, diseases, fire, etc. Likewise, some of us could use information on the availability of minor species, waste wood, and whether we can expect more or less competition from other wood-using industries in the years to come. Since many of us as pulp producers should know more about what we can look forward to as a raw material to work with, we have asked Victor S. Jensen who is in charge of the White Pine-Hardwood Research Center of the Northeastern Forest Experiment Station located at Laconia, N. H., to speak to us this afternoon and answer some of the questions posed above. He has selected as the title for his talk "Pulpwood Resources in Northern New England."

Even though on the decline country-wise as brought out earlier, sulphite pulping is still a substantial factor and especially in our three northern New England states which pro-

A. E. Jones, Oxford Paper Co., Rumford, Me.

duce nearly one fifth of the total. Calcium is the principal base used but for reasons of chemical recovery, abatement of stream pollution, or recovery of heat value, other bases such as ammonia, magnesium, and sodium are finding wider and wider use even though they cost four to five times as much. Pulp from the ammonia process is understood to be similar if it is cooked to the same permanganate number as in the calcium process and pulp quality is a stand-off.

Our next speaker, Professor Lyle C. Jenness, Head of the Department of Chemical Engineering at the University of Maine at Orono, has carried out considerable experimental work on ammonia-base liquor, its recovery and re-use and no doubt will bring out in his talk that ammonia-base sulphite cooking liquor has been in use commercially for about 8 years and that it has several advantages over calcium as a base even though it costs more. Professor Jenness has selected as the title for his talk "The Recovery of Ammonia by Simultaneous Evaporation of Acid and Alkaline Waste Liquors and Re-use of It for Pulping."

John Evans, Editor of the *Paper Trade Journal*, in an editorial has stated that in the Northeast, paper mills are losing out on a good bet. In fact, they are missing out on a sure thing when they do not avail themselves of the opportunity for pulping hardwoods by the semichemical process.

Neutral sulphite semichemical also known more simply as semichemical pulping for high yield production of fibrous pulps is not a new process and dates back 75 years when Cross disclosed in a British patent that this process was a very satisfactory method for producing high yields from hardwoods of a pulp which would be especially suited for corrugating and test liner papers. Work carried out in the South and by the Forest Products Laboratory starting in the middle 20's had an important bearing on making the process commercially feasible.

Most of the plants practicing the semichemical process are located in the South with only a scattered few here in the Northeast. However, we are fortunate to have with us today R. J. P. Keswick, General Superintendent of the Bathurst Power and Paper Co., Ltd., Bathurst, N. B., who is going to tell us about semichemical pulping at his plant.

The final paper on our program this afternoon has to do with a problem which all of us hear about frequently and especially those who live in a town located near a sulphate pulp mill. Some of the remarks which we hear about the odors from these plants are not entirely complimentary. Many different methods have been investigated for eliminating or reducing this public nuisance.

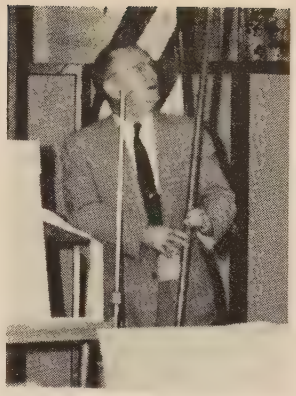
As mentioned earlier, the sulphate pulp industry has been increasing rapidly and the problem of malodors associated with this process has grown in proportion. Even so, the thought has been expressed that this one factor has materially retarded expansion of the process and in some instances no doubt it has even prevented its use no matter how desirable economically or otherwise.

Breekenridge K. Tremaine of the Organic Chemical Department, Chemicals Division of du Pont and currently acting Technical Director of the Industrial Reodorant Division of Rhodia Inc. is going to tell us about one of the methods for reducing kraft mill odors in his paper on "Recent Developments in Masking Sulphate Pulp Mill Malodors."

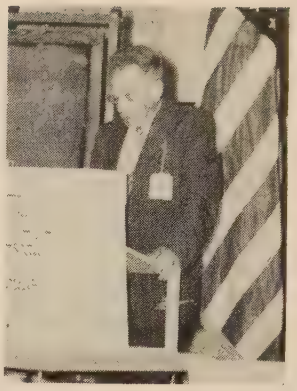
Pulpwood Resources in Northern New England

Victor S. Jensen

Statistics were given on forest land acreages, timber volume, and per cent by species, pulpwood production by species, and commodity production by timber products. The relationship of the current annual net growth to the commodity drain of timber products for Maine, New Hampshire, and Vermont, was shown.



L. C. Jenness, University of Maine



V. S. Jensen, U. S. Forest Service

Of the 4 million cords of hardwood consumed annually in the United States about 10% is used in Maine, New Hampshire, and Vermont. Maine is seriously overcutting their wood resources compared with New Hampshire and Vermont. Deer are a serious threat to the regeneration of fir and hemlock.

Increased yields of pulpwood can be obtained by utilizing the semichemical and Chemigroundwood processes, using waste woods, using other wood supplies not now used such as hardwoods and low grade wood, and finally by better management of the wood supply to prevent diseases, fires, and insect ravages.

Victor S. Jensen, White Pine-Hardwood Research Center, U. S. Forest Service, Laconia, N. H.

The Recovery of Ammonia by Simultaneous Evaporation of Acid and Alkaline Waste Liquors and Re-use of It for Pulping

L. C. Jenness

Several attempts have been made to recover ammonia from waste sulphite liquor of the ammonia-base type by methods of pyrolysis and combustion. Literature available to the author indicate rather incomplete recovery and inconsistent results. This situation may result from the difficulty of controlling a reducing atmosphere during combustion and from the ease with which nitrogen passes from one valence to another.

It has long been known that solutions of simple ammonium salts will liberate ammonia gas when they are heated if the solution is sufficiently alkaline. Richter (*1*) proposed that this principle be taken advantage of to recover ammonia from such solutions. As far as known to the author his proposal has not been reduced to practice. It would generally be uneconomical to use commercial alkalies to make sulphite waste liquor sufficiently alkaline to effect this process.

The purpose of this investigation was to evaluate the efficiency of industrial wastes, such as soda or kraft black liquors as such neutralizing agents and to recover ammonia gas liberated by subsequent evaporation of such mixtures of liquor. It was further desired to compare the use of such recovered ammonia with commercial ammonia for pulping wood by the sulphite process in order to indicate the feasibility of re-cycling a fraction of ammonia used to make sulphite pulp.

RECOVERY OF AMMONIA

A preliminary investigation of the distillation of ammonia from mixtures of kraft waste liquor and ammonia-base sulphite waste liquor indicated the feasibility of the process. In order to increase the scale of operation, however, an in-

L. C. Jenness, University of Maine, Orono, Me.

directly heated, single tube evaporator was constructed and operated by Ayer and Stoddard (*2*). The results obtained by them are reported by the author in *Tappi* (*3*).

For the purpose of this discussion those results are presented again in Fig. 1 from which it will be noted that as the fraction of feed evaporated increases the percentage of ammonia recovered increases and the concentration of ammonia in the condensate decreases. The former, rather gradual increase of recovery of ammonia, indicates that an appreciable length of time of contact is required to effect complete recovery of ammonia. The decrease of concentration of ammonia in the condensate is, of course, due to the fact that as the concentration of ammonia in the liquor mixture decreases the ratio of water to ammonia distilled in the evaporator increases progressively. It is to be further noted that although the recovery of ammonia from a 2:1 mixture of kraft liquor and sulphite liquor is smaller than that from a 3:1 mixture the smaller ratio of kraft liquor mixture allows larger concentrations of ammonia in the condensate.

If such a recovery process is to be used industrially the condensate from steam traps of the evaporator chests would be utilized, after adequate cooling, for the preparation of raw sulphite acid. As will be seen from Table I, if such acid was to contain 1.0% mill combined sulphur dioxide the makeup liquor to the tower should contain 0.5% ammonia by weight. It will further be observed from Fig. 1 that this concentration of ammonia is not attainable from mixtures of kraft and sulphite liquors fed to the evaporator in a ratio of 3:1 unless a negligible amount of feed is evaporated. It is attainable, however, from a liquor ratio of 2:1 provided that the ammonia recovered is contained in the condensate from not more than one fifth of the feed. As can be seen from the upper curve for the 2:1 ratio of liquors, this range of operation would allow recovery of 75% of available ammonia in the feed.

Obviously, if make-up ammonia for acid making is added as a strong solution, or as anhydrous ammonia, a larger fraction of evaporated feed could be utilized and more than 75% of the ammonia available in feed to the evaporator could be recovered. Since there would be unavoidable losses of ammonia in wash water, however, it is likely that 75% over-all recovery would be the maximum unless ammonia was stripped from all condensed steam from a multiple effect evaporator, which might or might not be economical.

USE OF RECOVERED AMMONIA FOR PULPING

Having decided that a comparison of pulping with recovered ammonia and commercial ammonia should be made with sulphite acid containing 1.0% mill combined sulphur dioxide, it became necessary to recover ammonia as a solution of at least 0.5% ammonia by weight. It was decided to use an experimental long tube evaporator for this purpose which equipment has been described by Dinsmore (*4*). The recovery and subsequent pulping experiments were performed by Cooper and Snow (*5*).

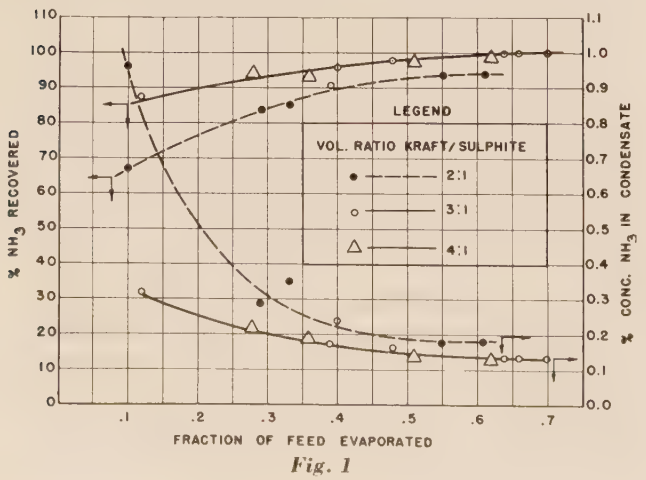


Fig. 1

Table I. NH_3 Concentration versus Per Cent Combined SO_2 (Mill)

$NH_3 + H_2O + SO_2 \rightarrow NH_4HSO_3$

Basis 100 lb. liquor

Mill comb., % SO_2	*True comb., % SO_2*	*SO_2, lb.*	*NH_3, lb.*	*NH_3, %*
0.50	1.0	1.0	0.266	0.27
0.80	1.6	1.6	0.425	0.42
1.00	2.0	2.0	0.532	0.53

The recovered ammonia solution of the desired strength and quantity was prepared by the simultaneous evaporation of a mixture of kraft and sulphite waste liquors in a volumetric ratio of 2:1. The product collected from a surface condenser was 0.53% ammonia by weight which was diluted to 0.50% ammonia and made up to acid containing 6.0% total sulphur dioxide and 1.0% mill combined sulphur dioxide. This acid was used to make several experimental cooks of mixed spruce and fir chips, four of which results are tabulated in Table II.

The cooks referred to in Table II as "Com." were made in a similar manner except that the acid was prepared from commercial ammonia instead of recovered ammonia.

It will first be observed from Table II that although the yields from the first five cooks are rather low the results from those made with recovered ammonia compare favorably with the first cook utilizing commercial ammonia. The low yields are believed to have been due to the use of chips that contained about 20% moisture and which may have been drier than that at some time. Another point of interest is that although the unbleached pulp brightness of pulps made by recovered ammonia was lower than those made with commercial ammonia the bleached brightness compares favorably with substantially the same consumption of bleach.

The second commercial ammonia cook was made on chips of over 25% moisture and indicates a reasonably high yield although the pulp from it was somewhat harder to bleach.

These pulps were also evaluated for physical characteristics of freeness, burst, and tear from which results no significant difference was apparent between pulps from recovered ammonia and commercial ammonia.

CONCLUSIONS

1. About 75% of available ammonia in waste sulphite liquor of the ammonia-base type can be recovered by simultaneous evaporation of it with kraft waste liquor and the condensed ammonia solution is suitable for the preparation of ammonia-base sulphite cooking acid.
2. Although ammonia recovered by this means has a strong odor of mercaptans no harmful effects were observed on the bleachability and physical characteristics of pulps prepared from sulphite acid utilizing the recovered ammonia.
3. Although the mixed waste liquors tended to foam badly during evaporation no scaling difficulties were experienced over a long period of time.

LITERATURE CITED

1. Richter, G. A., U. S. pat. 2,047,032.

Table II

Cook no.	*Time, hrs.*	*% Yield — Screened*	*% Yield — Rejects*	*$KMnO_4$ no.*	*Brightness — Unbleached*	*Brightness — Bleached*
Com.	6.5	37.0	2.8	7.8	49.0	85.6
1	7.0	36.9	3.0	8.8	39.6	...
2	6.2	37.3	2.9	6.0	41.1	87.1
4	6.0	36.6	6.0	11.2	36.1	...
5	6.3	32.3	6.9	9.2	31.2	83.0
Com.	6.5	44.5	2.0	7.6	48.0	79.9

2. Ayer, J. E., and Stoddard, E. A., The Recovery of Ammonia from Ammonia Base Sulphite Pulp Mill Waste Liquor, Thesis (1952) for M.S. Degree, University of Maine, Orono, Me. Microfilm No. 3785, American Documentation Institute, Washington, D. C.
3. Jenness, L. C., Durst, R. E., and Thode, E. F., *Tappi* 36, No. 8: 337–342 (Aug., 1953).
4. Dinsmore, R. F., *Paper Mill News* (Feb. 14, 1953).
5. Cooper, S. R., and Snow, H. E., The Recovery of Ammonia from Ammonia Base Sulphite Waste Liquor and Its Use as a Constituent of Fresh Cooking Liquor, Thesis (1953) for M.S. Degree, University of Maine, Orono, Me. Microfilm No. 4120, American Documentation Institute, Washington, D. C.

The author and his colleagues wish to express their appreciation to the Gottesman Foundation and The University of Maine Pulp and Paper Foundation for providing financial assistance in the prosecution of this investigation. They are also grateful to the Eastern Corp. and the St. Regis Paper Co. for supplying raw materials used in this study.

Semichemical Pulping at Bathurst

R. J. P. Keswick

For some years semichemical pulps have been manufactured from hardwoods in both continuous and conventional digesters. Results proved that corrugating mediums made from such stocks produced a superior quality container, particularly improving rigidity and ability of the combined board to withstand pressure without collapsing the fluted medium.

Bathurst's New Brunswick timber limits are well stocked with deciduous growths of maple, beech, white and yellow birch, ash, and poplar. These are intermixed with coniferous stands. The proximity of these growths permits economical cutting of hardwoods along with softwoods from the same bases of woods operation. The harvesting of softwoods only for many years allowed the hardwoods to start spreading gradually into the cut-over areas of softwood. Any feasible means of using the hardwoods advantageously would assist in conserving the softwoods, both in volume required to operate the mill and in assisting reproduction.

The advantages of hardwood densities ranging up to approximately 50% more than softwoods and a yield of 75% or higher, made a semichemical pulping project appear particularly attractive, resulting in the designing and construction of such a plant at Bathurst. All engineering and erection were completed by the mill staff. Generally speaking, all industries have found that continuous output produces a better quality product at lower operating costs. Consequently, continuous cooking apparatus was selected.

WOOD HANDLING

Rough wood in 4 and 8-ft. lengths is delivered to the mill by trucks and stored on both sides of a steel-lined concrete conveyor using a $1^1/_8$-in. cable with round buttons. The cable and buttons rotate slowly, so that they wear evenly and flat spots do not develop on the buttons.

A rail track runs on either side of the conveyor with the track forming a semicircle around the head drive. A portable conveyor feeder on the track may thus be positioned at any location along the conveyor. This portable feeder is loaded by a crane.

The conveyor and feeder drives are so synchronized and interlocked that it is impossible to overload the conveyor. Should a large quantity of wood be dumped on the feeder, it slows down, then speeds up when light. If the conveyor drive should trip out, or the cable stop, the feeder also stops.

A section of the conveyor is used for wood washing before delivery to the chipper. This section, inclined at 15°, is 40 ft. long. Kraft screen-room filtrate at 100 p.s.i. is pumped through banks of three nozzles at intervals of 10 ft. The conveyor buttons carry a certain quantity of water ahead of the wood. As the slope of the washing section increases, the water cascades back down the slope, sluicing off any dirt loosened by the nozzle jets.

R. J. P. Keswick, Superintendent, Kraft Pulp Mill, Bathurst Power Paper Co., Ltd., Bathurst, N. B.

CHIPPING AND SCREENING

The main conveyor delivers wood to a 90-in. ten-knife Carthage chipper with 19-in. spout, belt-driven by a 400-hp. motor mounted on a Rockwood base. Chipper speed is 305 r.p.m. Knives are changed every 4 hr.

Chips fall to two surge bins equipped with star feeders delivering to two 6 by 14-ft. Dillon triple-deck vibrating screens in parallel. Top screen size is $1^3/_4$ in. and intermediate $^5/_8$ in. The bottom section was originally plated, but the air concussion produced by the vibration of the plate caused damage to windows and light walls. The section was removed and a sawdust hopper constructed. A worm conveyor in the bottom of the hopper transports sawdust to the accepted chip elevator, thus all fines are contained in the system. Oversize chips fall to a 34-in. ten-knife Carthage rechipper with a blowing hood and a pipe which returns chips to the surge bins.

Accepted chips drop to the boot of a Jeffrey centrifugal discharge bucket elevator of 12,000 cu. ft. per hr. capacity, delivering chips to a steel-plate and reinforced-concrete chip silo with a wedge-shaped bottom.

A variable speed, rotary vane feeder rolls chips from the bottom of the silo onto a troughed endless belt discharging to a Link-Belt elevator capable of handling 3000 cu. ft. per hr. This elevator delivers chips over a Dings-perma-drum magnet to a chute having a pneumatically operated dividing plate which proportions the chips between two units. Two Jeffrey spiral conveyors pass the chips onto conical-shaped hoppers over each reaction unit.

All equipment transporting chips from the silo to hoppers is electrically interlocked.

COOKING EQUIPMENT

Each unit has the following equipment:

Chip Hopper. Conical shaped, supplied with steam inlets and temperature controller for chip presteaming; American Defibrator feeding chute and Bathurst-designed indicator for full hopper.

Chip Feeder. American Defibrator type D 9-in. screw feeder with 50-hp. variable-speed Reliance drive.

Reaction Unit. Six one-way flow 2 by 19-ft. B.K. reaction chambers of 90 ft. effective length, completely stainless clad with stainless screw conveyors, all supplied by Pandia and driven by a 10-hp. variable-speed Reliance drive.

Discharge. American Defibrator preheater screw, type D defibrator and continuous blow valve. Defibrator is belt-driven by a 250-hp. motor.

Flow of chips from hoppers is aided by a vibrating plate directing the flow into the screw. The converging flight of the screw, running in its tapered throat, compresses the chips into a practically solid mass which is forced through a plug pipe at the discharge end of the screw feeder. Splines on the throat prevent the plug of chips from turning with the screw, causing the plug to be pushed forward without rotation. Compression is enough to contain steam pressure of 170 p.s.i. A series of holes in the bottom of the throat permits the drainage of liquids squeezed out of the chips.

Immediately after the plug pipe is an expanding length where steam and liquor are added before the chips are pushed forward to a drop-off into the first reaction chamber. Steam at this point has a secondary use, assisting in separation of the chips for uniform cooking as well as supplying energy for pulping. A safety line, venting steam and chips should a blow-back occur, discharges into the chip silo through a cyclone.

Cooking pressure of 160 p.s.i. is maintained by a Foxboro

automatic steam pressure controller. Liquor is injected by Milton Roy variable-length-stroke dulpex plunger pumps supplied by Consolidated Engines & Machinery Co.

All reaction chamber screw conveyors are driven by chains from one conveyor sprocket to another. All screws turn and transport chips at the same rate. The pitch is 1 ft. throughout.

Since this equipment is operated continuously, it is essential that all drives be interlocked in the order of defibrator, preheater screw, reaction chambers, screw feeder, and chemical pump. Failure of any motor in this sequence automatically stops those listed thereafter. Automatic controls also stop the screw feeders and chemical pumps if there is a failure of steam or air supply.

Defibrators are driven at 600 r.p.m. by V-belts off a 250-hp. motor. Disk setting is maintained by tension on a heavy volute spring. The power drawn by the defibrator motor varies with each complete revolution of the reaction chambers. Blow valves are set only sufficiently open to prevent plugging the defibrators.

STOCK-HANDLING EQUIPMENT

Stock is blown into a cyclone equipped with jets for dilution and drops to a reinforced concrete chest with Sherbrooke propeller agitator.

A Canadian Allis-Chalmers high density pump delivers stock through a DeZurick pressurized consistency regulator and a Dings magnetic separator to a refiner headbox which supplied two Sutherland 48-in. refiners driven by 350-hp. motors. The headbox permits varying proportions of recirculation. A remote control electrically operated valve on the blow-chest-pump discharge controls flow to the refiners.

Refined stock flows by gravity to the vat of a 9 by 16-ft. two-stage Swenson-Nyman brown-stock washer. Washed repulped stock drops to a Stebbins Semtile storage tank of 6000 cu. ft. capacity with a Sherbrooke vertical-shaft agitator, having six adjustable-pitch propellor blades.

By removing one blank, the Swenson-Nyman washer is by-passed, unwashed refined pulp then being delivered to the storage chest.

Machine furnish is pumped through a DeZurick pressurized consistency regulator to a chest maintained at a selected constant level by an automatic control valve. Twenty per cent kraft furnish is metered into the same chest by a Trimbey proportioning meter.

Mixed furnish is refined through three Sutherland 48-in. refiners in parallel and a Miami no. 6 jordan in series after the refiners, then delivered to a machine chest. The 0.009-in. corrugating medium is run over a 160-in. Walmsley fourdrinier paper machine formerly operated on newsprint. Maximum trim is 146 in.

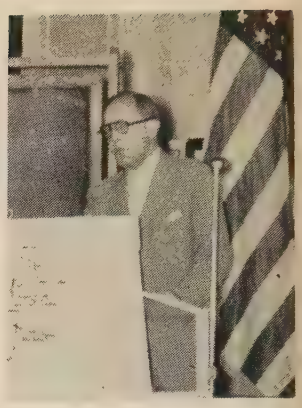
White water from the wire pit is returned to the pulp mill for dilution. Fourdrinier shavings and stock from the couch pit during start-ups and breaks are pumped to the storage chests.

CONTROL AND OPERATION

The operating panel on the main floor was supplied by Peacock Brothers, Foxboro instruments being used throughout with only one or two exceptions. All push buttons on the panel are equipped with pilot lights and ammeters. A quick survey of the panel tells the experienced operator how all equipment is functioning.

A measure of the design and operating efficiency is reflected from the fact that only two men per shift are required to operate the plant. A third man on the day shift only attends to liquor preparation, lubrication at 24-hr. or less frequent intervals, and cleaning. The operator and his helper run the plant from the operating floor, one or the other going to the defibrators on starting up or shutting down, or to do periodic checking of equipment.

R. J. P. Keswick, Bathurst Power & Paper Co.



B. K. Tremaine, Rhodia, Inc.

Chemical consumption, normally about 5% Na_2O on moisture-free wood, may be corrected very accurately by changing the stroke of the Milton Roy pumps. Adjustments of 10 to 20 gal. per hr. are possible. The units are operated to pH of blown stock, usually about 8.5, and the volume of liquor varied to arrive at this test.

Cooking time ranges from 12 to 18 min., the higher density woods requiring a longer reaction time. Woodyard operation endeavors to supply a constant species mixture, thus enabling the pulp mill and paper machine to maintain a more uniform operation. This, of course, is not always possible, but attempts in this direction do assist even production.

Steam consumption is controlled by the discharge area of an adjustable continuous blow valve. The valve is set only sufficiently open to blow at the rate of production without plugging the defibrators. If the valve is set too wide, there will be wastage of steam, the stock will appear to be wet, and there will be indications of poorer defibration caused by less dwell time in the defibrator. Steam used for cooking only is approximately 1500 lb. per ton.

Stock quality may be varied by defibrator setting, consistency to refiners, refiner setting and condition of disks in both defibrators and refiners, as well as chemical consumed and reaction time. The flat crush test on the finished board appears to be particularly affected by refining. A change of 20 to 30 points in freeness at pulp mill refiners may affect the crush test by as much as 25%. Scheduled tests are taken for pH of blown stock, liquor strength, consistency to refiners, and freeness of refined stock. Telephone communication with the machine room assists liaison and cooperation between the departments as well as supplying complete interchange of test results.

If one would consider that the chip hoppers were a surge point in the system, or if they were maintained at a constant level, it would be correct to say that this plant operates as a continuous unit from the chip silo forward.

Generally speaking, these units run very well, requiring only minor adjustments. The most important operating feature is to be sure that each successive stage is taking away chips at *not less* a rate than it is receiving them, or serious plugs will occur.

COOKING LIQUORS

Different cooking liquors have been used since the start-up of this plant. Among those tried were: white liquor of 35% sulphidity diluted 50% with kraft-mill black liquor, dilute white liquor of varying sulphidites from 7 to 35%, dilute commercial caustic, and dissolved soda ash.

All liquors produced a reasonable quality stock, but those having any Na_2S present gave a pulp which required washing to eliminate contaminating odors. The reclaimed black liquor did not contain enough solids or sodium compounds to return them economically to the kraft mill for evaporation and reburning. Consequently, when supplies of caustic

R. J. P. Keswick, Bathurst Power & Paper Co.; L. C. Jenness, University of Maine; A. E. Jones, Oxford Paper Co.: B. K. Tremaine, Rhodia, Inc.; and V. S. Jensen, U. S. Forest Service

became available it was possible to segregate the two mills, particularly to the advantage of the kraft mill, where the recovery and causticizing systems had been pushed very hard in order to supply additional chemicals.

After supplies of caustic became available, the sulphidity of white liquors was reduced in steps. When good results were obtained with 7% sulphidity liquor, it appeared that cooking with pure caustic would be feasible. A 24-hr. trial run indicated complete removal of odors. The brown-stock washer was then by-passed with no odor to be found in the finished board. This washer is still out of operation.

During the Winter of 1951–52, heavy snowstorms prevented scheduled delivery of caustic tank cars, with the result that we ran out of chemicals. Dissolved soda ash had to be used, producing nearly as good results as the caustic liquor.

MAINTENANCE

In many instances the production of conventional pulp mills is not seriously impaired by minor mechanical failures. In a continuous system a failure in any part of the equipment shuts down at least that particular unit. It is therefore essential that a preventive maintenance program be carefully scheduled.

Defibrator and refiner disks are examined during every weekend shutdown and the depth of grooves checked for wear. Experience with the amount of wear and visual examination of the stock prior to shutting down indicate when disks should be changed.

Defibrator glands are carefully checked to ensure that packing is not compressed to such a point as to lose lubrication. Packing left in too long will quickly score the stainless sleeve on the shaft, requiring about sixteen hours to change the sleeve.

Screw feeders and throats are changed after approximately 1500 hr. operation and the worn-off metal rebuilt by welding. This work must be done before the screw is worn to such an extent as to lose its pattern. The increasing power drawn by the motor-generator set for the Reliance drive gives a good indication of the condition of the screw.

There has not been any appreciable wear of reaction chambers or stainless reaction screws after a year and a half of operation.

Standard mill maintenance practice applies to all the other equipment, with particular attention being given to adequate lubrication.

GENERAL

Space has been arranged for the addition of two more reaction chambers to each unit. All pumps and handling equipment were designed for an ultimate production of 200 tons.

The corrugating medium with about 20% kraft stock furnish produces a flat crush test roughly double that obtained on the previously manufactured kraft medium.

While stock was being washed, yield was approximately 80%. Since then indications are that yield is appreciably over 90%. This may seem to be an unreasonably high figure, but actually the only losses from original wood are volatiles and fines in excess white water to sewer.

This semichemical pulp mill, all housed in one building approximately 50 by 200 ft., is the first in Canada to produce pulp continuously. The stock is a coarse fiber giving excellent results for its present use. Time and further study may probably lead to the continuous manufacture of higher quality pulps.

Recent Developments in Masking Sulphate Pulp Mill Malodors

Breckenridge K. Tremaine

Many of you have previously heard or read of the utilization of masking agents by the alkaline pulping industry for the abatement of kraft mill malodors. Therefore, I shall avoid a discussion as to the reasons behind their use, study, or adoption. I would however, like to bring to your attention a recent statement by a leading executive, who, speaking of the importance of abatement of air pollution stressed and I quote: "No matter how worth while or profitable, any enterprise will be curbed or eliminated if any part of its operation infringes too far upon public welfare" (*1*) That elimination of smoke, odor, and dust that may interfere with health, comfort, or safety is considered by many as vitally necessary as a good sewerage system, a safe water supply, and laws requiring standards of quality and cleanliness for milk and dairy products (*2*).

With this in mind, I call to your attention that masking agents are part of the tools toward overcoming an air pollution odor nuisance. They are not the complete answer, nor are they always 100% effective, but they are a tool which when properly applied will help to change the perception of the malodors from a sulphate process so that such odors are less intense, and free of the disagreeable odor of decayed cabbages or nauseating odor of rotten eggs.

The first technical report on the use of masking agents in alkaline pulping was presented in November, 1952, at the Sixth Alkaline Pulping Conference of the Technical Association of the Pulp and Paper Industry in Mobile, Ala (*3*). This report covered the masking of the principal kraft mill malodors (volatile sulphur compounds) by introduction of the masking agent into the digesters.

From these early tests, observations, and supporting laboratory work, it was generally believed that addition of the masking agent at the digester, with partial carry-over into the recovery system would give sufficient all-around protection. However, after nearly 2 years of study and tests by many mills, we have concluded that because of mill differences, practices, location, and cooking procedures, a single masking agent alone, based on these early recommendations, will not correct all sources of odor. Recent developments have shown that it is advisable to apply designed masking agents (*8*), not only in the digesters, but in the blowdown heat recovery system and the concentrated black liquor at the cascades. A review of each of these points will reveal the most recent developments in masking sulphate pulp mill odors.

DIGESTERS

Bialkowsky and De Haas (*4*) in their excellent studies of

Breckenridge K. Tremaine, Acting Technical Director, Rhodia Inc., New York, N. Y.

catalytic oxidation procedures for determining sulphur compounds in kraft mill gases, reported from 1 to 5 lb. of these types of malodorous compounds produced per ton of Douglas-fir depending, of course, upon pulping conditions; also, that cooking temperatures are a critical factor in fixing the amount of these compounds, that high temperatures favor their production, and that such sulphur compounds have very high vapor pressures, escaping during digester relief and blowing. Likewise, the publications of many other investigators such as Klason (*5*), Bergstrom and Trobeck (*6*), confirm the importance of the digester system as a source for volatile sulphur compounds. These compounds can be detected in extremely dilute concentrations. Thorough investigations by the U. S. Public Health Service (*7*) have shown that the odor threshold detection values of hydrogen sulphide, methyl mercaptan, and dimethyl sulphide are 1.1 micrograms per liter. This is somewhat less than 1 p.p.m. on a weight basis. Bialkowsky (*4*) states these figures would be more readily realized when we consider that if 1 lb. of these materials is evenly dispersed in an air volume over 1 acre in area to a height of 300 ft., they could still be detected by the sensory organs.

It is therefore obvious that the digester system is a major contributor of malodors; consequently, the use of masking agents in the digester is necessary even though it isn't a cure-all for the problem at hand. Meuly (*3*) reported a masking agent when used in the digester to have sufficient masking value, if all of it became air-borne, to be four to eight times the minimum amount required to produce an odor modification when used at 10 to 20 p.p.m. based on the digester content. This type of original masking agent for use in the digester, which since its inception has been copied, is used extensively.

However, this type of product and the copies of the prototype have limitations based on their physical-chemical properties as follows: (1) a limited solubility in an aqueous system; (2) high boiling characteristics necessary for cooking stability, but with insufficient volatility for instantaneous release in early relief.

Realizing the need for further masking we embarked on an extensive study of kraft mill malodors at locations partly removed from the digester itself. Our program has indicated that improved odor control is possible when a dual treatment is established. This treatment consists of applying the masking agent to the digester cook and also in heat recovery system. The digester application is made at concentrations much lower than heretofore recommended, usually in the range of 45 to 90 grams per ton, or somewhat less than 2 oz. per ton of pulp. This may depend on wood conditions, sulphidity, and operation of blowdown heat recovery.

HEAT RECOVERY SYSTEM

The treatment in the blowdown heat recovery system utilizes a surface or jet condenser as a scrubber. An initial application from 20 to 40 p.p.m. is employed by adding the masking agent to the contaminated water from the accumulator, followed by regular additions of 5 to 10 p.p.m. into the system during the blowdown period of each digester. This operation helps to abate the noncondensible gases which may be released from the steam jet. Obviously the masking agent must be soluble in the aqueous phase and possess excellent volatility characteristics. The cost of treatment for this dual application is less than $0.20 per ton of pulp.

BLACK LIQUOR ACCUMULATOR TO CASCADES

It is assumed in accordance with the literature that correct furnace operations leave no organic sulphur compounds in the flue gases, all being oxidized to SO_2. The only organic sulphur-type malodors contained in the stack gases should be released at the cascade evaporators.

A recognized malodor to atmosphere from such a source is hydrogen sulphide (H_2S) a weakly acidic, foul smelling gas resulting from the two-stage hydrolysis of sodium sulphide in the early stage of processing as:

$$Na_2S + H_2O \rightleftarrows NaHS + NaOH$$
$$NaHS + H_2O \rightleftarrows NaOH + H_2S \uparrow$$

This gas is liberated at any point where liquor is evaporated. Thus its release during the final evaporation of heavy black liquor is a point for consideration. Mixed in this fume waste is also some methyl mercaptan, (CH_3SH) also a weakly acidic gas, present in the black liquor as its sodium salt which reacts with water to give the gas as indicated by the following:

$$CH_3SNa + H_2O \rightleftarrows NaOH + CH_3SH \uparrow$$

Observations made during many mill tests and often supported by analytical examination by the mills themselves have shown that hydrogen sulphide in the flue gases may average at the bottom of the stack in some cases, in excess of 300 p.p.m.

Ghisoni (*10*) in reviewing this source for malodor, carried out an accurate analysis of waste water and smokes. In the stack gases he made the following determinations (*11*):

		CH_3SH	H_2S
(1)	After rotary furnace and boilers, mg./cu. m.	50	...
(2)	After disk evaporator, mg./cu. m.	250	...
(3)	At the bottom of the stack, mg./cu. m.	100	330
(4)	At the top of the stack, mg./cu. m.	50	120

Our calculations indicate the above concentrations may be expressed in parts per million, as follows:

		CH_3SH, p.p.m.	H_2S, p.p.m.
(1)	Rotary furnace	17	...
(2)	Disk evaporator	85	...
(3)	Bottom of the stack	33	110
(4)	Top of the stack	17	40

Upon becoming air-borne, these odors may be recognized because the accepted threshold odor value is below 1 p.p.m. The malodor present in these recovery fume gases is noticed on some occasions more often than on others. We feel that the odor perception is influenced by the small quantities of SO_3 in the fumes; the effect of the odor of combustion which may mask some of the malodor; or, because when evaporating, black liquor with hot flue gases containing CO_2 there is liberated twice as much malodor per pound of water removed as does concentration by distillation.

We believe modification of the malodors picked up at the cascade evaporator is necessary. The actual distribution of air-borne malodor from the cascade evaporator represents approximately 30% of the total malodor released to atmosphere from the sulphate system. This was reported by Meuly (*3*) and is presented in the following chart:

	Distribution of air-borne malodors, % of total	*1952 Degree of masking*	*1954 Degree of masking*[a]
Digester relief gas	15.25	Some	Fair
Digester blowdown	Min. 25	Good	Good
Multiple stage evaporator	Max. 30	Fair	Good
Cascade evaporator	Max. 30	Fair	Excellent

[a] Bases: Practical mill application and observations, B.K.T.

To provide adequate odor abatement at this source, a product was prepared which when mixed with the concentrated black liquor (approximately 55%) in an accumulator prior to entering the cascade evaporator does provide uniform odor

abatement with a marked reduction in the intensity of such malodors. This treatment is a very simple one and the concentration of the masking agent required is approximately 7 to 10 p.p.m. based on the total volume of black liquor to the recovery system. The masking agent is generally applied by gravity into the outside or inside accumulator tank, assuming agitation is available. This quickly assures complete saturation of the black liquor with the masking agent. From this point of application, the masking agent is then picked up from the concentrated black liquor as gases from the combustion, leaves the economizer, and picks up moisture and odor, and eventually becomes air-borne. The masking agent has good volatility with a later stage release at 200 to 300°F. An initial odor change is apparent, yet there is enough stability to retain the masking value under temperature variations. Generally the flue gas temperatures entering the direct gas contact evaporator is above 500°F, but on leaving is in the range of 275 to 300°F. The cost of treatment based on estimated 600-ton pulp capacity daily is about 0.624 to 0.105¢ per ton of pulp.

MILL OBSERVATIONS

The comments of mill observers now using a dual treatment with the broader application at the recovery are as follows:

Mill A. A considerable abatement of the kraft malodors at this plant was noticed as evident by comments from various mill personnel as well as by a careful check of the mill area and surrounding countryside over a period of 5 days.

Mill B. There was some resistance to the use of the masking agent from plant operating personnel due to the odor of the masking agent itself. However, after running approximately 48 hr., the plant personnel became accustomed to the odor and did not object to using it. Several of the mill personnel indicated that there was a definite improvement in the mill area itself as evident by the fact that their clothes did not smell of the usual kraft odor.

Mill C. We hired a plane so that a definite check could be made on the recovery gases emanating from the stack after application of the masking agent. At a distance of $2^1/_2$ miles, the technical director perceived a very slight pleasant odor. This was true regardless of whether the altitude was 1000 ft or 500 ft. At a distance of approximately 1 mile from the plant, a very slight combustion odor was noticed. This odor was definitely combustion rather than the strong sulphides and mercaptans usually associated with a kraft odor. Even when we flew directly through the stack gases at very close range, the odor was not strong nor could it be associated with a kraft odor. When a plane is used and flying directly into the plume of smoke and gases emanating from the recovery building stack, there is no question about whether you are getting a true picture of the effectiveness of the masking agent. The report of the pilot was that this was the first time he had ever flown in the mill area that he did not smell the plant.

Mill D. The mill manager and superintendent accompanied us on a couple of blows in the late afternoon and early evening and they all expressed the opinion that the odor of the paper mill had been greatly improved—that the new odor would certainly not be objectionable to anyone.

Mill E. The vice-president in charge of engineering, informed us that he thought a well-operated and efficient mill who selectively cook their woods did not have to use a masking agent. However, his director said he did not agree with this and that fumes containing mercaptans and other sulphides still occur in the best regulated mill, although perhaps to a lesser degree, and that it would be foolish to return to the old system of not using a masking agent.

WEATHER CONDITIONS VERSUS ODOR PERCEPTION

There is another phase of any odor abatement program which we believe plays an important part when using masking agents. We refer specifically to the study of local weather conditions. Knowledge, particularly of temperatures, humidity conditions, inversion levels, and turbulence, is of great importance. Accumulation of such data will enable an operating mill to use masking agents based on periodic treatment, and thus obtain lower costs of application. For this purpose, we have a slide which covers the typical diurnal sequence of turbulence and dispersion to odors on clear or partly cloudy dry days. The weather condition from which this chart was made would be characterized by strong turbulence in the middle of the day and relative strong temperature inversions at night with little turbulency (*9*).

The above sequence of dispersion events was determined for meteorological conditions of essentially clear dry weather, moderate wind speeds, 5 to 10 m.p.h. In damp rainy weather, tests would probably indicate that the change in turbulence would not be as great or as rapid. Consequently, this would be an important period when odor masking would be employed. The conditions as illustrated were made for an area located in the Southwest. Obviously, the conditions in the Northeast would perhaps show a different type of curve. Likewise, the conditions on the Pacific Coast would differ from the East Coast. Thus each mill area may differ and it is recommended that seasonable tests be made to determine how often and how frequent masking agents should be used.

CONCLUSION

There are, of course, many unexplained variables encountered in the use of masking agents. But they are today the most logical tool for use in correcting an odor nuisance from a sulphate pulp system, provided, that designed masking agents (*8*) are used in the system itself. The use of masking agents do not incur major capital expenditures. Any improvements which may come from the use of these products will only occur if the alkaline pulping industry as a whole accepts them. Many pulp mills have pioneered in their study but there is still a tendency for many to sit by and wait for the reports of the other fellow. What you may hear may be inconclusive, since each mill and its operating conditions differ.

What you will obtain from the application of masking agents is better public relations, higher property values, better employee relations; and that is considered by many executives, as good business.

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Pacific

The joint annual meeting of the Pacific Section of TAPPI and Pacific Coast Division of the American Pulp and Paper Mill Superintendents Assn. was held at Gearhart, Ore., May 20–22, 1954, with a registered attendance of 426.

The meeting was officially opened on May 20 with registration starting at 2:00 p.m. and a buffet supper served from 8:00 to 1:00 p.m.

On May 21, F. J. Weleber, Publishers Paper Co., presided over a joint session wherein the following papers were presented:

"A New Unit of Chip Measurement and Methods of Chip Compaction," by Edmund Ericksen, Longview Fibre Co., Longview, Wash.
"Comparison of Log Barkers," by William E. Beeman, Crown Zellerbach Corp., Portland, Ore.
"Chips—Saws to Cars," by Thomas R. Miles, Consulting Products Engineer, Portland Ore.

At 11:00 a.m. the annual TAPPI business meeting was held which was principally for the election of officers. The following were elected for the 1954–55 year: E. H. Nunn, chairman, John McEwen, vice-chairman, H. B. Petersen, secretary-treasurer. Executive Committee: John Ayres, B. T. Briggs, F. R. Hamilton. F. J. Weleber, chairman for the past year, officially turned the gavel over to E. H. Nunn who then called a meeting of the new Executive Committee.

At 12:00 noon, the same day, Frank M. Warren, Jr., executive vice-president, Portland General Electric Co., Portland, Ore., addressed a joint luncheon on the subject, "Power in the Pacific Northwest."

At 2:00 p.m., Max A. Bailey, Westminister Paper Co., Ltd., presided over a general session and Frank A. Guba, Carpenter Steel Co., presented a paper, "Economics and Conservation with Newer or Higher Alloys."

At 3:00 p.m., Cecil Taylor, Columbia River Paper Mills, presided over a papermaking discussion group, Thomas H. Grant, Publishers Paper Co., presided over an acid pulping discussion group, and L. D. McGlothlin, Crown Zellerbach Corp. presided over a kraft pulping discussion group.

The rest of the day was given over to dinner and informal dancing.

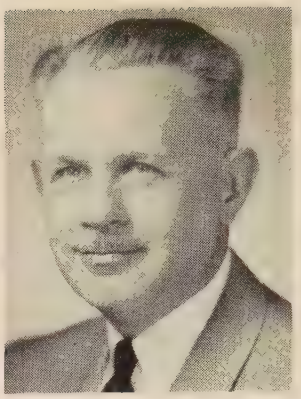
At 8:00 a.m., May 22, the Portland International Brotherhood of Migratory Peddlers put on their usual Wake-Em-Up Breakfast and this was followed at 9:30 a.m. by a general session presided over by E. H. Nunn, Crown Zellerbach Corp. The following papers were presented at this session:

"Hot Pressing on Paper Machines," by W. W. Clark, Longview Fibre Co., Longview, Wash.
"Effective use of Manpower," by Gus Ostenson, Crown Zellerbach Corp., Camas, Wash.
"Reduction of Wood Waste," by C. C. Heritage, Weyerhaeuser Timber Co., Tacoma, Wash.

The men's golf tournament was held during the afternoon, followed by a get-together party, banquet, and dancing.

Plans were initiated during this meeting for a three-way get-together in Victoria, B. C., next May.

H. B. Petersen, *Secretary-Treasurer*



E. H. Nunn, Crown Zellerbach Corp.; Chairman, Pacific Section

J. M. McEwen, Weyerhaeuser Timber Co.; Vice-chairman, Pacific Section

A New Unit of Chip Measurement and Practical Methods of Chip Compaction

Edmund Ericksen

Rising costs and diminishing log supplies after World War II brought a renewed interest in the potential of sawmill and veneer plant wood waste as a source of raw material for the pulp and paper industry. In 1950 the Longview Fiber Co. entered into agreements for the purchase of chips with the knowledge that a variety of problems were to be resolved as the program progressed and expanded. The new phase of chip procurement also brought into being the transportation of large volumes of chips by truck and rail carriers.

Between May, 1951, and August, 1952, data collected from 1246 rail car shipments of chips to the Longview Fiber Co., included wet weight, moisture content of wood, dry weight, and settlement in transit. Investigation of these data revealed a very large variation of the moisture-free weight of wood contained in a 200-cu. ft. volume unit and an average of 19% settlement in transit. Observations, during this same period, at sawmills and plywood plants indicated chip loading to be affected by the rate of loading, height of fall from the conveyor to the car, and a jackstraw effect created by the tumble action of chips during loading.

Two problems were recognized as having a definite impact on the long term outlook of utilizing wood waste as chips. A need arose to: (1) establish a more uniform unit of measure to replace the inconsistent 200-cu. ft. volume unit, and (2) derive a method of compacting chips to a maximum practical density.

NEW UNIT OF MEASURE

In 1926 tests were conducted, under joint supervision of Longview Fibre Co. and Long-Bell Lumber Co. representatives, to determine a satisfactory unit of measure for chips made from sawmill wood waste. Initial tests showed a number of factors influencing the volume of chips derived from a 128-cu. ft. cord of piled wood. The problem was then approached on the basis of the moisture-free weight of wood in a 128-cu. ft. cord.

Ten 4 by 4 by 8-ft. cords of closely piled wood waste were obtained from the Long-Bell Lumber Co.'s refuse conveyor. This wood was placed in a dry kiln and dried to uniform moisture content ranging from 3 to 7%. Each cord was then independently and accurately weighed. A number of small samples were taken from each cord and further dried to a moisture-free content to determine the per cent of moisture-free weight of wood. The average moisture-free weight per cord was 2404 lb.; this figure when rounded off became the 2400-lb. moisture-free unit or B.d.u.

For the past 27 years the B.d.u. has been the accepted unit of measure between the Longview Fibre Co. and Long-Bell Lumber Co., during which period nearly 2,000,000 B.d.u.'s were purchased on this basis. In the past year a number of new agreements, in which the B.d.u. is the unit of measurement, have been entered into by the Longview Fibre Co. and sawmills and plywood plants. In all future contracts the B.d.u. will be used as a unit of measure.

Realizing the responsibility for making accurate weight and moisture determinations, the Longview Fibre Co. has installed a Fairbanks-Morse track scale of 250,000-lb. capacity.

Edmund Ericksen, Wood Procurement Engr., Longview Fibre Co., Longview, Wash.

Summary of Data

Type of loading	Average per cent of level capacity upon arrival at Longview	Average (2400 lb.) B.d.u.'s	Average moisture-free wt. per 200 cu. ft.	Average moisture-free wt. per cu. ft.	Average per cent load increase	
Natural gravity (level full)	86.48	16.331	1952	9.760	Base	...
Natural gravity (16-in. crown)	98.42	17.950	2146	10.729	10.99	Base
Conveyair (level)	92.37	20.125	2406	12.026	23.22	12.09
Conveyair (16-in. crown)	100.51	22.097	2641	12.205	35.30	23.08
Deflector and oscillating car (level)	..	20.220	2417	12.084	23.81	12.63
Deflector and oscillating car (16-in. crown)	..	22.340	2670	13.351	36.79	24.44
Conveyair and oscillating car (12-in. crown)[a]	..	22.410	2551	12.754	30.68	18.87
Deflector and oscillating car (12-in. crown)[b]	..	21.256	2541	12.703	30.15	18.40

[a] Edward Hines Lumber Co.
[b] Associated Plywood Inc.

Moisture sampling equipment consists of a specially designed mechanical sampler that gives a representative sample from each carload of chips as it is being unloaded. This sample is dried in a J. O. Ross oven constructed for that purpose, and moisture is determined by weighing the chip sample before and after drying.

The system of weighing and moisture sampling is controlled by men trained for the purpose, whose sole duty is chip quantity and quality evaluation.

CHIP COMPACTION

After a number of unsuccessful attempts to compact chips with high frequency vibrators; arrangements were made for testing the Conveyair system, as a chip compaction device, at the Longview Fibre Co.'s wood chipping plant located near Eugene, Ore.

Conveyair is a system primarily designed to convey bulk materials by air. Chips enter Conveyair through a receiving hopper and are compressed into a plug by a powered screw feeder. The chip plug, acting as a seal to prevent blow-back, moves forward metering the chips into a mixing chamber where they are picked up by an air stream and carried in suspension through a metal tube of suitable diameter. Velocities range from 6000 to 8500 f.p.m. and air pressure varies from 3 to 8 p.s.i. dependent upon the distance chips are to be conveyed.

Tests were made to determine the per cent load increase by comparison of level full car loading by Conveyair with those loaded by a natural gravity fill from conventional flight or belt conveyors. Conveyair equipment, used for the test, consisted of a 12-in. diameter screw feeder powered by a 25-hp. motor; three blowers, each belt connected to a 25-hp. motor and 40 ft. of 14 gage metal tube 5 in. in diameter. This particular system has a capacity of 30 units per hr. with air pressure ranging from 5 to 7 p.s.i.

Tests were conducted in September and October of 1952 during a period of little or no rainfall, thereby reducing the variable of added moisture in transit. Sixty-five test cars were loaded at Eugene, Ore., and shipped 173 miles to Longview, Wash. All cars were weighed at the Longview railroad terminal to determine gross, tare, and net weights. Each car was sampled for moisture content to determine the per cent of moisture-free weight of wood. Settlement was also measured to obtain the per cent of level capacity upon arrival of the Longview Fibre Co.

Chips loaded by a natural gravity fill have a tendency to roll and tumble creating a jack-straw effect that gives a minimum of compaction. Air delivery at high velocity tends to conteract this jack-straw effect by delivering the chips with sufficient force to spread them over a greater area; to laminate, interlock, and butt the chips one against the other, thereby contributing to compaction and increased loading. Conveyair, level loaded test cars, showed an average load increase of 23%. The addition of a 16-in. crown or surcharge showed chip car arrivals at Longview averaging 100% of level capacity and having an average combined load increase of 35%.

FLOW DEFLECTOR AND RECIPROCATING CAR

The flow deflector and reciprocating car method of loading was developed for chip compaction at plants using flight or belt conveyors. The theory of this method was to spread chips over the greatest possible area of a car to achieve lamination and interlocking for maximum compaction. It was impractical to spread chips over the entire area, consequently a flow deflector was devised to spread chips the width of a car and the car was continuously moved back and forth to obtain lengthwise distribution in the car.

A number of deflection devices have been tried with varying degrees of success. The more common types are a cone, frustrum of a cone, conical section, pyramid, and slope sheet. The flow deflector for test loading chip cars was an irregular pyramid, the peak being inserted into the center of the chip stream. Data obtained on chip cars loaded by a flow deflector and reciprocating car motion were compared to those loaded by a natural gravity fill. Level loaded cars showed a load increase of 24%. The addition of a 16-in. crown showed an average combined load increase of 37%.

COMPACTION IN OPERATION

Based on test results, two compaction systems were placed in operation. The Edward Hines Lumber Co. of Westfir, Ore., installed Conveyair as part of the primary chip handling equipment. Chips, at this source, are conveyed approximately 600 ft. prior to being compactly loaded into a rail car. Associated Plywood, Inc. of Eugene, Ore., added a flow deflector to the existing car loading facilities. Additional equipment at both plants, in general, consists of a reciprocating car haul with electric panel for automatic control and photoelectric apparatus for limiting car reciprocation. Chip cars, at these two sources, compactly loaded and having a 12-in. crown show on average combined loaded increase of 30%.

SUMMARY

We believe the experiments and practical application of compact chip loading to be a major step in the development of a chip procurement program. Better use of transportation equipment and extension of economic transportation limits should add to the future development of wood waste utilization.

The B.d.u., as an actual measure of the moisture-free wood content in a compacted load, is a further contribution to a chip procurement program.

Together, chip compaction and the B.d.u. indicate definite progress in the field wood chips saved from waste to make paper products.

Comparison of Log Barkers

W. H. Beeman

SINCE the installation of the first successful whole log barker on the Pacific Coast not much over 10 years ago a

W. E. BEEMAN, Crown Zellerbach Corp., Portland, Ore.

number of hydraulic and mechanical log barkers have been developed. Some of these designs have been abandoned because they did not do the job or because a different type was found to be more suitable. In some instances the emphasis has been on the preparation of material for wastewood chipping and not on pulpmill logs alone.

The intelligent selection of the most suitable type of barker for a given mill can be done only after evaluating a number of factors. For instance, "complete barking" appears to be a relative term. Barking which might be considered adequate for a container board mill might be unsatisfactory for a sulphite mill. In some pulp mills speed of barking is a controlling factor while in a sawmill a slower pace may be possible because of the limitations of other equipment in the mill. Water supply and disposal of effluent, size and species of log, intended location of the barker reserve-log-storage facilities must be considered. All of these and many other factors, including personal preference, will enter into the selection of a barker.

No attempt is made here to compare the costs of the various barkers. The final cost of a barker installation often includes a number of expensive items such as conveyors and transfers and may mean the reconstruction of a portion of the existing mill. Each complete installation, of course, must be "tailored" to fit the needs or preferences of the mill management. For instance, barker units quoted at $60,000 may require a total outlay of $300,000.

Time does not permit a discussion of the relative merits of all of the log barkers on the market. However, a brief description and performance record of a few of them may be of interest.

The Weyerhaeuser pulp barker was one of the first hydraulic whole log barkers on the Coast. It began operation at Weyerhaeuser mill A in Everett in August, 1942. Barking in this model is done by rapidly moving a jet of water longitudinally along the underside of the log. The log is held down by toothed chains which turn the log at each passage of the nozzle into the end zone, the amount of turning being controlled by the operator. Power requirements are 500 hp. to supply about 1000 g.p.m. at 1,350 p.s.i.

Installation of this barker marked a great reduction in the crew and in wood losses compared to previous methods. However, repair experience is not reported to be the best. About 1200 tons of chips are prepared by this machine in 8 hr.

A similar barker was installed in the Weyerhaeuser kraft mill at Longview in 1945, using a shot-gun feed on the nozzle.

Another early design was the Port Townsend or Crown Zellerbach barker designed by Harry E. Bukowsky. The log is revolved between centers much the same as a peeler log in a veneer lathe. Bark is removed by the action of a jet which acts on the log in a manner similar to that of a lathe tool. Some difficulties are experienced due to the time required for chucking. Many logs with unsound and shattered ends, also small chunks, cannot be handled readily. This barker is being replaced by other designs which handle logs better. However, it makes good use of power and does a thorough barking job with good operator control.

In 1946 Weyerhaeuser installed at their mill no. 1 in Longview a barker designed for very large logs. In this design the log is kicked out of a horizontal section of the log haul and transferred back into the log haul after barking.

Motion of the log is a slow forward and rotation combined, so that the barked area is a spiral which overlaps enough to secure complete bark removal. Two nozzles directed from below the log have rapid angular movement in direction of the log axis, one moving to the left from a meeting point and back, the other moving to the right and back.

This barker is said to be economical of power, reasonable in construction cost, and generally suited for large logs. It was designed for log up to 60 ft. in length, 10 ft. in diameter, and 45,000 lb. in weight. The barker has an average barking cycle of 2 min. per log which is ample for the cut of 50,000 f.p.h. at this mill. This barker requires only 600 hp. to furnish approximately 550 g.p.m. at 1400 p.s.i. This barker is not considered fast enough, nor suitable for mills sawing a large number of smaller logs.

One of the most popular types of hydraulic log barkers is the Bellingham barker. The original installation was at Puget Sound Pulp & Timber Co. at Bellingham. A total of 22 of these barkers are now in operation, or on order. This barker is particularly suitable where a large number of logs of varying sizes must be handled, and the length of logs is not excessive. This barker has an extremely high capacity in that the loading and unloading of the logs, in and out of the barker can be accomplished rapidly. However, water consumption is considered high for fast, clean barking of medium-length or small-diameter logs.

The log is rotated on trunnions which normally include intermediate rolls if 8-ft. logs are to be barked. In recent models the overhead nozzle can be raised or lowered to accommodate any size log. The nozzle jet discharges at about 12° from the vertical. The nozzle head on late models may be revolved through a full circle which permits cleaning of punky sections or shattered cracks.

In one recent nozzle design a double jet at each end of the nozzle head serves to break up cedar or redwood bark into shorter strips, reducing a troublesome waste problem. A sweeping action of the nozzle from side to side is helpful on flat or odd-shaped logs and for sweeping the log-decks of bark.

The Sumner Iron Works in Everett builds the Bellingham barker in sizes to handle from 8 to 44-ft. long logs from 6 in. to about 10-ft. in diameter. Power requirements vary.

The Worthington whole log barker is built by the Worthington Pump & Machinery Corp. Whole logs are barked in this machine by passing them axially through the barking zone on ribbed rolls which can be run in either direction at a speed selected by the barkerman. Barking is done by a number of nozzles which are mounted on a lower and two side manifolds. The position of manifolds is varied so that the nozzle can be kept at a selected distance from the log, which is usually 15 to 16 in. Of the 36 jets, only those needed to cover the log are used at one time. Extra water not required for a small log goes into the accumulators, to be fed out by air pressure when required for a large log. All water is shut off when no log is in the Worthington barker. Two 1250-hp. motors operate one pump each, providing 160 g.p.m. per nozzle at 1200 to 1400 p.s.i. Total water usage, of course, varies with the number of nozzles in use.

Tight-barked logs must sometimes be run through the barker three to five times to remove all the bark. Very large logs will have unbarked strips and must be turned and passed through again.

Western Barker's rotary-head barker, commonly referred to as the Simons barker is manufactured by Western Barkers, Ltd. of Vancouver, B. C. In this barker also the log goes through the unit without being revolved. The water stream is applied to the log through a rotating nozzle with a vertical spindle, one about the one under the log. A recent installation designed for 60-in. logs has installed 2300 hp. to furnish 1700 to 1800 g.p.m. at 1500 p.s.i. A 30-in. model uses 1500 g.p.m. Barking is good on medium-sized logs but is poor on the sides of large logs which must run back through to complete barking. There are now seven of these barkers in operation.

The Hansel Engineering Co. of Vancouver and Seattle makes two quite different types of hydraulic log barkers. The first of these is the Hansel ring barker, originally developed at the Crown Zellerbach mill at Camas by Frank Swift. Some 20 of these machines have been built to date. Ring sizes vary from 30 to 70 in. The nozzles are mounted in pairs which balance the thrust from jet reaction. The inner

part of the ring is driven by V-belts. This barker requires absolutely clean water to reduce wear on the plastic seal ring. The new MacDonald molded plastic ring appears to give much longer life than the original Celeron type, having given as much as 8 mo. service in one instance before being replaced. However, another mill reports only 2 weeks' life with the same plastic ring, but adds that even this is an improvement over their previous experience. A limitation of this barker design is in log size. In some installations the ring is moved aside for logs too large for the ring. In other mills oversize logs by-pass the barker. Power requirements vary, of course, with the size of the ring. A 30-in.-ring uses a minimum of 600 hp. to pump 600 g.p.m. at 1300 p.s.i. The 70-in. ring requires a minimum of 900 to 1200 hp. The Bingham eight-stage pump appears to be a favorite for use with this and other hydraulic barkers.

The new Hansel oscillating-arm or wig-wag hydraulic barker is an attempt to produce a lower priced hydraulic barker that could be placed in the log haul. It was intended for use with the water source available to the mill, regardless of contamination. Further, it is expected by the manufacturer that any repairs can be handled by the millwright. Two of these barkers have been installed—one at Western Forest Industries at Honeymoon Bay, B. C., and the other at Universal Lumber & Box at Vancouver, B. C.

The Vancouver installation contains two large oscillating nozzles, one on each side of the log and a smaller top oscillating nozzle. The flap across the log haul controls the length of the stroke of the nozzle arms, the speed of the stroke, and the speed of the log haul all through a series of follow-up cylinders and levers. The operator is able to override this automatic action if desirable. Barking is good except for a narrow strip of bark on the underside of the log. Modification of the design to correct this deficiency does not appear difficult.

The log haul speed varies from 15 to 60 g.p.m., depending on the size of the log. Universal Box is barking 180 M per shift of logs of all sizes. Power requirements are approximately 1200 hp. to provide 1000 to 1200 g.p.m. at 1300 p.s.i. Power requirements would be less for mills barking all small logs.

While this barker has not been in operation long enough to be entirely proved, it appears likely to fill the needs of some types of mills because of comparatively low cost, the use of unfiltered water, and the possibility of barking logs of varying diameters and any length.

Mechanical log barkers are becoming increasingly important to the pulp and paper industry.

They have a definite place in veneer plants and in some sawmills which are or might become a source of pulp chips. Most veneer plants use the lathe type of mechanical barker with either a rosser, scraper, or compression type of head. The correct combination of barking heads and care by the operator can be factors in increasing the yield of bark-free chippable veneer.

Many small and medium-sized sawmills (i.e., from 50,000 to 150,000 board feet log scale per shift) have limited water supply and therefore must often choose between a mechanical log barker or none at all. Mills of this size seem to be the next frontier in the search for increased quantities of waste-wood chips for the pulp and paper industry.

Experience on the West Coast with mechanical log barkers suitable for sawmill type logs is limited. However, several designs are being installed experimentally with varying degrees of success.

The Nicholson Roto barker is manufactured by the Nicholson Manufacturing Co. of Seattle. Installations have been made at Cascade Lumber Co., Yakima, Wash.; Twin Feather Mills, Kamiah, Idaho; L. & K. Lumber Co., Vancouver, B. C.; and C. D. Johnson Lumber Co., Toledo, Ore. At least seven other machines are on order.

This is a ring-type barker with ring sizes of 30, 40, or 60 in. The maximum effective log diameter for barking is about 8 in. less than the ring diameter. Bark is removed by five scrapers, each mounted on an air-actuated arm within the revolving ring. The scrapers revolve about the log and closely follow the log contours. Hold-down wheels prevent the log from turning while passing through the ring. Barking is good, even around knots, if the machine is not overcrowded. One 40-in. barker handles 125 M feet of logs in 8 hr. Maximum efficiency requires variable speed drives on both the feed and the ring; otherwise, barking is often incomplete.

Power requirements are small. The 30-in. ring uses about 30 hp. and the 60-in. requires 60 to 75 hp. Installation costs are substantially below costs for a hydraulic barker of comparable size.

The Prentice log barker is made by the E. V. Prentice Co. of Portland. Three machines have been installed in California to bark redwood. The Prentice is a mechanical floating-cutter-head-type machine which barks the log while still in the pond. The log is rotated and fed under the cutterhead by endless drive chains passed around the log with a slight offset to give forward motion. Adjustment of cutting depth is controlled through hydraulic guide shoes which rest on the log surface. Refuse removal is by means of a blower unit which draws material from the cutterheads. Capacity is rated at 120 M log scale in 8 hr. on redwood logs averaging 24 ft. long and 29 to 30 in. in diameter. Total power requirement is 225 hp. The installation price seems moderate.

The Burnt River barker built by Sumner Iron Works is an experimental design developed at the Burnt River Lumber Co. at Baker, Ore. Three additional units are under construction. This unit is designed to bark logs 8 ft. or longer and 6 to 50 in. in diameter. Speed of operation ranges up to a maximum of 30 lineal f.p.m. The original model has a capacity of 140 to 150 M in 8 hr. Power usage is 135 hp. exclusive of the compressor motor. All barking heads, hold-down rolls, brushes, and jump rolls have air cylinders.

In operation, the logs are lifted from the pond by a jack ladder, then are carried through the barker on trunnion wheels which rotate the logs during its passage. Bark is removed by revolving side heads with angled teeth somewhat like helical gears. Rotating wire brushes located a few inches behind the heads remove the cambium layer and slivers.

Observers report that this barker will not work well on logs with limbs or will not get the bark from the crevices of the butt cuts. Some slivering of the log surface was also noted. This machine is, of course, too new to permit accurate appraisal of its potential effectiveness.

There are many types of mechanical pole barkers and "peppy peelers" which do not properly seem to come under the classification of log barkers. One of these which has been redesigned to bark logs up to 36 in. in diameter is the Nelson pole peeler. This hydraulically controlled machine straddles a conveyor which moves the logs past a set of floating cutterheads. The log is turned as it is conveyed lengthwise. Capacity is rated at 50,000 board feet per 8-hr. day of fairly straight logs. Barking is incomplete in crevices but might be satisfactory for container-board mills.

A few comments on the possible returns from log barking in sawmills may be of interest to those responsible for chip procurement. Savings resulting from higher lumber-grade recovery, greater volume recovery, reduced saw maintenance costs, less clean-up, and less dogging damage are reported to be $1.00 to $2.50 per M ft. of lumber cut. Average savings for large mills appear to be slightly over $1.00 per M.

In addition to the above, there is a much greater return because of the increased chip production. Production of chips in sawmills in the Douglas-fir region averages about 0.2 unit per M ft. net log scale of clean wood only. With adequate rip-sawing and slab barking, this chip recovery may be

0.35 unit per M ft. With whole-log barkers the recovery is 0.6 to 0.7 unit of chips. One fairly large mill cutting small logs reports 0.83 unit per M ft. Since small-log mills produce fewer chips per M ft. without barkers, there appears to be some basis for expecting log barkers to give the greatest increase in chip production in mills sawing small-diameter logs. The ratio of chip production to log usage is at a maximum in sawmills producing chips for container board mills or other mills having flexible chip length or bark requirements. Pulp mills requiring a high uniformity of chip length can expect somewhat lower quantity recovery.

I am convinced that the pulp and paper industry has much to gain by encouraging the development of reasonably priced log barkers suitable for installation in medium sized sawmills. The successful accomplishment of this objective will yield rich returns in increased quantities of chips from mill waste still going to the burners.

Economies and Conservation with Newer or Higher Alloys

Frank A. Guba

THERE is no doubt that the problems facing the pulp and paper mills are so parallel to other processing industries that failures of equipment with resulting loss of production so affect its business and profits as to make the study of costs very imperative. A major study of equipment and what it is made of; how it operates; and the requirements of corrosive protection of both plant and product is important to maintain plant economy, and that economy is greatly affected by the proper selection of materials for equipment. It is not always the best economy to buy the cheapest materials; for example, a 2 in. Schedule 40 IPS in type 304 or 316 may last 3 to 5 years in a special application at a cost of from $4.00 to $5.00 a foot, after which the material is lost by corrosion erosion or scrapped, but a tube of higher alloy and lighter wall may last indefinitely at a cost of possible $4.50 to $5.00 a foot, and a considerable saving of critical material is affected.

We must remember that plant economy and conservation go hand in hand over the long pull. In the critical situations which we find ourselves from time to time, our shortages of critical materials usually arise from the fact that in the times of plenty, we buy for price and because of false evaluation, we have used up a lot of material that could have been stockpiled for emergency. Without a stockpile to draw on, we are faced with a serious drain on our resources.

Every industry has such problems, particularly where metals are the mainstay of processing equipment. Corrosion is, of course, the greatest problem. So often in the interest of retarding corrosion, we lose sight of the waste of metal which the elimination of the corrosive hazard could accomplish.

Since I am more familiar with the stainless steel tube and pipe industry, I would like to clarify that statement by directing attention to another condition in industry where millions of pounds of metal are lying idle in pipe lines because one half to two thirds of the wall thickness is useless for corrosion resistance.

Where the pipe is joined by threading, that part of the wall required for cutting threads is cut away for the full depth of the thread and miles of 2-in. pipe of about 0.154 wall is only as effective as a pipe with about 0.065 wall. In other words, we can do the same job with a pipe having about a 16-gage wall and save one half the cost of material and more than one half of the material itself.

In some cases, heavy wall tube or pipe is used for welded lines in order to retard corrosion and make it last as long as possible. The analysis is usually picked because of its per pound cost, as well as its length of service. This saving in cost per pound may be the most fictitious thing about the economical use of material. Frequently the thinnest wall, even though the material may be higher in cost per pound or foot, will eliminate the problem of corrosion. If a heavy wall pipe will completely resist corrosion, a light wall pipe will also last indefinitely.

How can this be effectively carried out. First of all, the industry has made possible the selection of three distinct weights of pipe, Schedule 5, Schedule 10, and Schedule 40. Schedule 5 is approximately one half the cost of Schedule 40. Therefore, in the same alloy, approximately a 50% saving in cost can be accomplished; and Schedule 10 is an intermediate between 5 and 40 with about one half the saving in price and weight of material as is affected by the use of Schedule 5. New alloys perfected by the industry now permit us to weld safely most analyses of stainless steel without the hazard of intergranular corrosion in the adjacent area. I am sure you are quite familiar with the general concept of corrosion of stainless alloys that I need not go into that specific detail. However, if anyone wishes to reacquaint himself with these details, they are referred to the paper, "Corrosion in the Pulp and Paper Industry."

This safety in welding of which we speak is made possible by a reduction of the carbon content of the stainless to 0.03 in some of the alloys which is a fairly recent and more economical method, or by using one of the stabilized alloys containing columbium or titanium. Both 304 and 316 can be furnished with either low carbon or as columbium stabilized. Titanium in 304 is available as type 321, but since titanium is a rather volatile alloy, we usually suggest this alloy be used for higher temperature use up to 1700° instead of for welding. Methods of joining such light walls in either pipe size o.d. or tubular sizes is made possible by fittings of the correct size and corresponding wall thickness and in the same alloys so that a lightweight assembly of highly corrosion-resistant material is the result.

In our present National economy we know that in industry it is up to us as was demonstrated recently that we must cooperate in conserving raw materials if we can save one half the weight of a stainless steel pipe line. We have added to our stock pile or raw materials for emergency use just that much material. If we can save 10 or 20 gages of wall thickness by using a higher alloy at a higher cost, we have saved just so much more material, and possibly have completely eliminated a problem of corrosion by increasing the corrosion resistance to a point where the higher cost of material is insignificant.

Labor today is a most important cost of maintenance problems, and since much of the replacement cost is composed of labor, we can see a great economy in longer use of higher alloys.

To assist in such corrosion and material economy by using lighter walls, the industry has brought out on the market various alloys to combat many conditions that just a short time ago were most bothersome.

I refer to alloys marketed as Carpenter no. 20 and Carpenter nos. B & C. These alloys correspond to Duriment 20 which has been available in the past only in cast form known as "Duriment 20." The B and C alloys are made from Hastelloy B and C sheets, and like all other stainless tubes, are welded with the inert gas shielded arc method.

Before we discuss the above alloys, we would like to bring to you a few remarks about another alloy, type 329, which recently has come into more popular use.

Some are well acquainted with all of these alloys, but a general review of them will be informative. Let's take them step by step.

Type 329 has been on the market for a number of years mainly in the form of bar stock and used for hardenable parts. It is a 23 to 28% chrome analysis, $2^1/_2$ to 5% nickel, moly 1 to 2%. It is an intermediate alloy more ferritic in nature than

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austenitic, but can be annealed by water quenching from high temperature. Unlike any of them, it precipitation hardens when soaked at lower temperatures and cooled slowly in furnace. In hardening, heat to 1350°, soak at least 12 hr., and cool slowly in furnace. A Rockwell of C-45 can be obtained, making it suitable for bushings on stainless steel shafts. Corrosionwise, it has an excellent field since we have learned how to roll it into strip and weld into tubes. Due to the limitation of strip width at the mills, it is available more in the heat exchanger evaporator and condenser sizes; about $2^3/_4$ od is the present limit. Its best corrosion resistance is in the fully annealed condition being on about the same level in corrosion resistance as 316. It provides excellent high-temperature oxidation resistance up to about 1900°F. Its ferritic nature makes it much more resistant to stress corrosion cracking than any of the austenitic steels in the same corrosion range. There is no difficulty in welding or brazing, and we suggest welding with either 329 rod if available, or with 316 if for straight corrosion, or no. 20 if for stress cracking, according to conditions could be considered as one of several candidates for weak acid lines to absorption towers, in pressure absorbers for higher concentration of sulphite liquors, in Mitscherlich digesters, or in heaters and recovery systems. Its ductility is more than sufficient for good rolling into tube sheets but requires more power since it is stiffer than most other stainless alloys. Tensile strength 100,000 p.s.i. at 2% yield, 80,000 p.s.i. elongation in 2-in. 25%, and reduction of area 50%.

Here then is an alloy requiring less than one half the amount of nickel required by other alloys of similar corrosion resistance and with properties that make it available for some of the more severe erosion conditions. Comparison of its thermal conductivity with that of 316 shows 150 B.t.u. per sq. ft. per hr. per °F. per in. at 500°F. as against 128 B.t.u. for type 316.

As more severe corrosion problems arise such as are found in the acid plant cooling pipes, no. 20 alloy should be considered on account of its excellent resistance to sulphuric acid. Lead, which has been used mainly for such applications although its corrosion resistance is excellent, its structural and fabricating properties leave much to be desired. While in this case it might not be its greatest weakness, we still point out that its corrosion resistance depends on a product of corrosion namely, lead sulphate. This protection will often be destroyed through the nonadherence of this film on account of velocity or turbulence. This material from a mechanical standpoint is, of course, very heavy and weak. Therefore, it required expensive supports and generally high maintenance costs, not only because of design but on account of the special skills of the mechanics required in installing. Therefore, unless there are high concentration and temperatures of sulphuric acid involved, we suggest looking into more economical rolled materials for construction.

Other alloys less resistant to sulphuric acid would be on a par with no. 20 in sulphite liquor use provided the assurance of sulphuric acid-free conditions could be had in the equipment. This no. 20 alloy composed of 20% chrome, 25% nickel, 2% moly, 3% copper, and stabilized with 8 by 6 content of columbium requires no anneal after welding. It is also more resistant to stress corrosion cracking although not entirely immune to it. The charts show it as being possible to use with some degree of resistance at 60° Be. or 78% sulphuric, and it shows excellent resistance at concentrated levels of 10 to 20%, and at temperatures of 50 to 80°C. While 316 and 317 have shown excellent resistance to the sulphite liquors (when free of sulphuric acid, calcium, and sodium bisulphite). The presence of weak sulphuric acid makes this alloy highly desirable on account of its corrosion resistance under all conditions. We think recovery systems will show excellent applications. We do not wish to belittle the effect of 316 and 317 in sulphuric acid resistance, but their rate of corrosion in this service is many times that of no. 20 alloy.

As our requirement for corrosion resistance increases, we look for alloys of higher content, and for sulphuric condition requiring boiling temperatures up to 50% concentrations, the alloy B shows excellent resistance. This alloy also is well suited for the boiling hydrochloric acid and hydrogen chloride gas, as well as many acids remote from pulp mill requirements. This alloy is used where reducing conditions apply. This material, of course, is not a steel containing but 4 to 7% iron with 26 to 30% moly, and balance nickel. From a standpoint of corrosion resistance, it is excellent for sulphuric acids at all concentrations and temperatures below 250°F. It is stronger and stiffer than the stainless steels, but can still be rolled into tube sheets under the proper conditions. It is also readily weldable, but should be annealed after welding in order to obtain maximum corrosion resistance. Its cost is considerably higher than any of the stainless alloys, but again, as so frequently is done, the thickness of wall can be controlled to make it more economical.

Riding higher and higher on the corrosion scale, we come to alloy A, again a Hastelloy strip made into welded tube. This alloy again is very low in iron content of 4 to 7%, with 15 to 17% chrome, 16 to 18% moly, 3.75 to 4.75 W., with small amounts of phosphorus, sulphur, and silica; and balance nickel. Here again we have high resistance to hydrochloric and sulphuric acids, particularly under oxidizing conditions due to the chromium content. It is one of the few metallic materials possessing adequate resistance to hypochlorites and other solutions containing appreciable amounts of free chlorine at room temperature or lower. It may be attacked at higher temperatures, especially over 100°F. It therefore shows excellent resistance to many of the bleaching solutions so commonly used in industry. In strong bleaching solutions containing over 10% available chlorine, caution is necessary as the alloy C might exert a catalytic action on the solution causing decomposition.

All the alloys mentioned are readily fabricated into process lines and equipment.

All but 329 are available in sheet and plate, but I understand a source for 329 sheets will be available in the future. All these alloys because of their high alloy content, have higher mechanical properties and therefore are stiffer, require more power to form—bend and roll into tube sheets. The proper welding rods are available for each alloy from various sources. No special skill is required to weld these alloys other than is required for the regular stainless steel grades, but frequently slower speed and higher temperatures are needed. Number 20 alloy welds and forms almost the same as 304, and as previously mentioned, sheets, plates, tubing, and pipe need not be annealed after welding as they are all columbium stabilized.

These alloys, except 329 which was previously noted, can be produced in a wide range of sizes from about $^1/_2$ to $4^1/_2$ in continuous welded mills. Sheets and plates provide a means of making larger diameter pipe and tube by press forming and welding separately in mills designed for this type of fabrication.

Fittings, both cast and wrought, are available in no. 20, B and C, at this time in the size ranges made in continuous welded mills, and are being fabricated from sheet and plate by the same fabricating plants who make the larger diameter tubing and pipe.

These, then, are the newer alloys available in tubular form that may meet many of the exacting requirements of the pulp industry.

It is interesting to note that the difference in cost between alloys is not always indicative of their performance. As previously mentioned, type 316 has been extensively used in sulphite liquors, but if corrosive conditions caused by weak sulphuric acid causes failure after a few years, look what a higher alloy could do under the same conditions.

Type 316, Schedule 40 pipe, if placed in an application which would be only partly resistant, would cost about $5.66 per ft., while no. 20, Schedule 5, which is highly resistant, is only $4.75 per ft. In a few years, the 316 pipe would perhaps be entirely disintegrated, while the Schedule 5 pipe in alloy 20 could give indefinite service.

We believe it pays to use the highest resistant alloy with the thinner wall for best economy.

Hot Pressing on Paper Machines

W. W. Clark

The use of heat as an aid to mechanical removal of water is not new in the pulp and paper industry. Hot water addition above the sheet at suction boxes of a pulp machine has been known to give a dryer sheet from the presses, and so aid in efficiency of drying, and has widespread use in the industry. In a like manner many pulp machines have one or two driers ahead of their last press to heat the sheet and aid in water removal.

Many operators in the fourdrinier and cylinder board business form their sheet at temperatures of 130 to 150°. In some mills this is done to aid water removal, and white water is heated with direct steam. In some cylinder mills, steam is used in the preparation of their stock as an aid to breaking down wet-strength materials or to homogenize the asphalted papers found in wastepaper furnishes and the heat is carried through to the machine with resultant aid in water removal.

We know of instances where a sheet of board has been heated ahead of a last press to aid in water removal and then the practice was discontinued for reasons not readily learned. Only one installation of a suction press in the drier section is recalled and that on a large kraft liner machine in the south. This was installed during World War II and later discontinued.

In recent years several installations have been made on food board machines where a short section of driers have been installed between the second press and the third plain press for the sole purpose of aiding in water removal.

Let us look at a little theory on the subject. What does heat do to the viscosity of water? Viscosity is expressed in the amount of force necessary to give movement to water. In the cold range from 40 to 100° the viscosity reduces very rapidly as temperature increases. The slope of the curve gradually flattens out as temperature gets higher so that the rate of change is moderate from 100 to 160° and above 160° the change is comparatively small. For purposes of this discussion, we are really dealing with the results of raising water temperatures from 100 up to 160°, with resultant drop of viscosity of 0.68 to 0.40 cp. or a reduction of about 40% in forces required to make water flow.

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We have been working with a fourdrinier machine which has a secondary headbox, and we initially used direct steam in water going into the secondary box to heat it to about 150 to 160° which was as high as we could get without having steam pockets squirting out the slice. The whole sheet was heated by displacement of cooler water from the primary sheet by the hot water from the secondary box. This aided in our water removal on the wire and in the presses, but the sheet cooled rapidly in the presses and sheet was barely over 100°F. coming out of the third plain press. This method of heating is quite costly as it uses large amounts of steam and of course the condensate is lost as far as reuse for boiler feedwater.

On some grades where we used no top stock in the secondary headbox we found that it was an advantage to run the hot water alone onto the sheet for heating the sheet. This can be done on any paper machine if a good distributing device is available to spread water uniformly onto the wire and it is a good place to use hot water that is recovered from sources of low gradient heat. It also should be noted that if this hot water that goes through the sheet is returned to the wire pit, a temperature rise also occurs in primary stock system.

In order to heat the sheet and get good water removal, ten 60-in. diameter driers were taken from the first section of driers and seven were then reinstalled directly after the second suction press and a suction press with 38-in. diameter rolls capable of giving 500 lb. per in. nip pressures was installed directly following. The suction roll has a cover of $^3/_8$-in. hard rubber, while top roll has a 1-in. thick self-skinning cover of 45 P & J plastometer. The preheaters are equipped with top and bottom felts and return felt driers. The hood over this section has no ventilation and is built to cut down natural air movement as much as possible. Nevertheless, there is enough evaporation in these heaters to keep the temperature from going much over 160° into the hot press. We have measured sheet temperatures here by two methods—neither of which is entirely accurate but is a good approximation.

One method is using a Cambridge pyrometer and the other a regular laboratory thermometer held next to the sheet and shielded with several thicknesses of paper held next to the web so that the only air which touches the thermometer bulb is that which is carried by the sheet travel into the pocket formed by the paper and the wet sheet. By these methods the sheet temperatures are indicated to be 160 to 163° ahead of the hot press and 140 to 142° after the press. The water removed from the saveall tray of the press is about 100°. Perhaps higher sheet temperatures could be reached if the area between the preheaters and press could be entirely closed off to prevent the evaporation which results from air circulation in this space.

Table I shows some moisture tests taken before and after the hot press installation. Average conditions entering the driers were about 32 to 33% dry fiber. After start-up we were without the second suction press for a few days so that sample of 1-4-54, shows results with one suction press and then the hot press. With the second suction press in operation the sheet coming out of the hot press became dryer.

Table I. Moistures Expressed as Per cent Dry Weight

	Date							
	2-26 1953	*4-5 1953*	*1-4 1954*	*1-18 1954*	*1-29 1954*	*3-27 1954*	*2-12 1954*	*4-26 1954*
Weight, lb.	32	45	45	45	45	42	27	27
Speed, f.p.m.	700	550	760	800	815	850	960	960
After Couch	22.9	21.2	...	...	21.7	17.2	19.2	17.8
After 1st press	30.5	25.8	29.8	33.0	27.0	27.7	22.9	26.2
After 2nd press	34.1	30.9	...	35.4	30.8	31.3	28.0	...
After 3rd plain press	34.2	32.3	...	...	...	...	...	...
After preheaters	...	...	30.9	36.5	31.2	33.3	28.9	30.0
After hot press	...	...	37.6	41.7	40.2	39.3	34.1	33.6
Nip pressures, lb. per in.								
1st press	194	194	205	204	204	197	204	194
2nd press	212	212	...	212	212	210	212	194
3rd plain press	210	210	...	...	...	...	...	...
3rd suction hot press	...	...	337	473	473	275	475	330

Table II.

Date	Speed, f.p.m.	Basis weight, lb.	Bursting strength	Stiffness With	Stiffness Across	Moisture, %	Caliper, in.	Jordan power Bottom stock	Jordan power Top stock	Steam pressure, p.s.i. Pre-heater	1st	2nd	Cal.	Steam per ton, lb.	Starch per ton at calender, lb.
Dec., '53	731	44.7	108.9	85.4	64.8	6.9	0.0131	1350	575	..	80	100	60	6426	11.15
Jan., '54	800	44.9	109.3	86.8	67.5	6.7	0.0122	1615	556	15	70	97	45	5538	9.85
Dec., '53	800	42.2	106.4	78.7	60.2	6.7	0.0124	1248	619	..	100	106	73	6754	...
Jan., '54	805	41.8	102.6	85.8	66.3	6.4	0.0116	1755	575	14	78	98	52	5802	...
Dec., '53	879	38.0	91.7	62.9	50.8	6.9	0.0111	1508	551	..	76	92	57	6528	...
Jan., '54	910	38.7	91.2	68.2	53.1	6.4	0.0106	1652	555	6	56	87	41	5913	...
Dec., '53	1050	32.3	70.8	50.2	39.9	6.6	0.0093	1585	533	..	58	87	44	6098	...
Jan., '54	1050	31.9	79.9	53.5	39.7	6.8	0.0088	1675	535	5	40	82	30	5627	...
Dec., '53	930	27.9	66.1	..	..	7.4	0.0091	1956	..	..	59	82	..	7144	...
Jan., '54	962	27.7	63.7	..	..	7.3	0.0083	1669	..	12	42	72	..	6573	.

Amount of drying in the preheaters as expressed in dryness figures, ranges from 2 to 9% loss of total water at this point. There is an appreciable loss of moisture from evaporation. The number of driers in this section is more than needed for rates presently being run. Water removed by the hot press is moisture that cannot be removed except by pressing at elevated temperatures or by drying and should be considered the gain of this system.

The 27-lb. corrugating medium shown on the table does not give the dryness that the liners do, one reason being that we have a great deal of trouble keeping the sheet from following the press felts out of the presses and in order to avoid wrinkles, allow the sheet to follow felt after the first press and after the hot press. We are still working on this as we can accomplish more if we can get the sheet to follow up the top roll coming out of the nip. This is a matter of getting the correct cover on the top roll of the press and getting a paper roll in right location.

The effect on the sheet from this kind of treatment is of interest and is perhaps the hardest thing to express with any certainty. Table II shows averages of runs of liner and corrugating medium for the month before the installation of hot press and the month after. All December figures were before shutting down for rebuild and all January figures were with the hot press. During the first 8 days of hot press operation, the second suction press was out of service which of course changed the operations. Other more obscure variations in process that can happen from day to day must be absorbed in general averages. Looking at the tabulation of these figures, burst, ring stiffness with Hinde & Dauch equipment, and moistures are comparable on most basis weights for both periods. All 42-lb. liner run in January was without the second press. Calipers on all grades were down considerably with hot press running. Note the steam pressures are lower in each section of driers during the January period which indicates that less steam is needed to dry the board. The lowered steam pressure necessary in calender driers indicates less water or starch solution being picked up from the box on the calenders and this is borne out by actual usage on the grades where starch is used and accounted for.

The figures in column showing pounds steam per ton are total steam usage for all purposes on the machine so cannot be said to be exact steam used for drying purposes only, but since drying is biggest variable, the difference in usage is approximate steam savings between the two periods tabulated.

There are other effects on the sheet of board that are not readily shown with figures; these must be described. Moistures are more uniform across the reel with the suction hot press than they were before because high moisture streaks are less likely to occur going into the driers following a suction press.

We do have a shell mark on the bottom side of the sheet which is not objectionable on liner grades. Lightweight grades run when the press felt is thin will show shell marks through to the top side of the sheet.

Choice of style of felt is important because felts with hard or prominent warp yarns will give yarn marking. The definite reduction in caliper from hot pressing indicates that the sheet will not readily recover from impressions made at this press.

Papermakers recognize the fact that the sheet becomes more tender in the first driers in a machine where the web is being warmed but no appreciable drying has occurred. Handling the sheet at this point can be a problem and we have found that it is hard to do by hand, however, using automatic rope passes the sheet works well and does not crush or give trouble in the press. We have been quite fortunate in this.

To sum up the results of reducing the number of paper driers from 54 to 51 and revision of the machine for hot pressing, drying capacity was increased by approximately 12 to 15%. Bursting strength and stiffness remained at about the same figures. Caliper was reduced 7 to 9% with resulting increase in sheet density. Steam savings on the over-all operation are indicated to be about 14% on heavier weights down to about 8% on lighter weights of board of total previously used. Disadvantages of shell and yarn marking are to be reckoned with but proper felts can help on this.

Organization Building for Effective Utilization of Manpower

Gus Ostenson

Back in the earlier days, some years before paper mills were established on the West Coast, there lived in this region, we are told, a great westerner by the name of Bunyan. When Paul Bunyan hooked up the traces on Babe, the Blue Ox, and set his hand on the plow to open up the Columbia Gorge, it is doubtful if effective utilization of man power was his major concern. Paul had only himself and Babe to manage.

Today the situation is different. An increasing number of people have responsibility for the best use of the services of others. Every man has a personal stake in the effective utilization of the skills and abilities of the people under his direction.

Moreover, we live in a period where conditions are fast changing. It is a continual challenge to us to keep pace. We must be flexible in our thinking and action. We must make adjustments to see that each and every man has the opportunity to fully utilize his talents and ambitions toward better and more efficient productivity in the enterprise in which he is engaged.

CORPORATE OBJECTIVE

Take our case, for example. Our business is pulp and paper. In this enterprise our corporation has an objective. As I see it, this objective is:

The manufacture and sale of quality products, in a manner and at a price, which will provide:

1. *Service* to the public.
2. Satisfactory *wages* to all employees.
3. Fair share of *taxes* to our government.
4. A *profit* in a competitive market.

Gus Ostenson, Manager of Paper Production, Crown Zellerbach Corp., Camas, Wash.

Failure to accomplish any one, or any combination, of these requirements could cause failure of the business. None of them can be accomplished unless production costs can be kept in line.

Looking back a few years, there was a period during World War II when management could add help to get needed production. At times it was almost a case of "get the job done at any cost." We all realize, however, that such a condition is the exception, not the rule. We all know that enduring success in American business depends on clean, free competition, and that when competition is keen we cannot afford to make some products unless unit costs can be kept in line. This calls for good management.

ASPECTS OF MANAGEMENT

There are many things that we in management can do to help our companies stay competitive and successfully provide the required service to those who are, or would be, our customers.

Some students of management, such as Lyndall Urwick, of Urwick, Orr, & Partners, Ltd., London, England, divide the field of management into seven aspects: controlling, forecasting, planning, organizing, commanding (supervising), and coordinating with communicating common to the other six aspects. Every one of these seven aspects represents important management skills. While they appear to be quite clear and distinct, they are, in fact, mutually interrelated and interdependent.

Suppose for a moment that the field of management represented a pie; and that the first six aspects were pieces of the pie. When your wife bakes you a cherry pie she can't bake it a piece at a time, can she? No! She must bake it as a whole. The pieces are interrelated and interdependent. So it is with the aspects of management. Communication, like the pie tin, appropriately circumscribes and links all the other aspects.

Each of you is interested in all of these different aspects of the management job. However, in the space at our disposal let us direct our attention largely to the activity of "organizing." More specifically, let us discuss "organization building for effective utilization of man power."

It has often been said that: "Management is getting results through people" (Sir Charles Renold).

We must "organize" to do this. As I see it, the job of management is to effectively put together men, machines, and materials in a harmonious working relationship to best achieve the objective of the enterprise.

My point is this: I believe that you can get more and better results through people by putting thought and time and effort into building up a good, sound, organization.

ORGANIZATION PURPOSE AND BENEFITS

According to John Bassill, president of the American ENCA Corp.:

> "The purpose of organization is to mobilize in the most efficient manner the various skills of the entire personnel and to direct those skills toward the attainment of certain common objectives."

Others may phrase the purpose a little differently. In the words of Lyndell Urwick, for example:

> "The purpose of organizing is to secure the maximum advantages and economies from the subdivision and specialization of effort, while at the same time retaining unity of effort, or coordination."

Would you agree from your experience that any company that builds a sound organization can survive many and serious hard knocks?

Andrew Carnegie once said:

> "Take away all our factories, our trade, our avenues of transportation, our money, . . . but leave me our organization, and in four years I will have re-established myself."

All of us have at some time seen the consequence of poor organization. Some examples are: (1) complacency, (2) personality conflicts, (3) breeds inefficiency, (4) improper balance of work, (5) failure to accomplish objective, (6) cumbersome procedures and operation, (7) poor morale, and (8) confusion. Have you observed any such evidence of unsatisfactory organization?

The values of good organization are many. Some that I personally have observed from our own efforts to build a better organization are: (1) improved relationship, teamwork, morale; (2) better communication; (3) cooperation and coordination; (4) responsibility and authority fixed; (5) promotes better supervision; (6) provides basis for training and development; (7) better balances work load; (8) greater productivity; (9) improved plans, policies, and procedures; and (10) essential to systematic and orderly growth. Have you also experienced such benefits?

ORGANIZATION BUILDING

By now you may have the impression that I am sold on the values of building a good organization. I am!

Since organization as we are talking about it today is made up of people, it is not just as inanimate, static skeleton on a chart or drawing, but combines the orderliness and system of a well-planned structure with all the feelings and attitudes of the people involved, and hence is dynamic, pulsing with life.

A good organization has been defined as a group of individuals who understand their relationships, who are continually becoming better qualified for their posts, and who are cooperating willingly and effectively to a common end.

Organization building, therefore, requires study of the structure and training and development of the people who staff the structure.

I would like to tell you something of what we have recently done in our paper machine organization building program.

This program involved all the members in our paper mill supervision. Our stated general purpose was: "To review the paper machine supervision organization, clarify the functions and relationships of each member, and gain common understanding of policies."

More specifically, we set out to: (1) clarify lines of authority, (2) clarify relationships of staff and line supervisors, (3) clarify the specific duties for handling the responsibilities at each level, (4) eliminate unnecessary duties and reduce overlapping, (5) make certain that all duties are covered by somebody without overloading any one position, (6) identify areas for delegation of duties, and (7) get uniform understanding between supervisory levels of the duties and responsibilities with which each is involved.

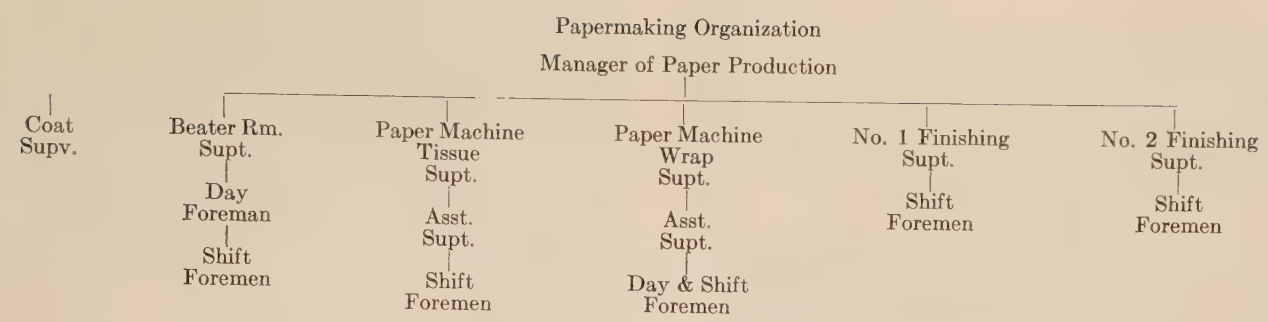
In an organized effort to accomplish these things the paper mill supervisors met as a group once a week for approximately 10 weeks in a series of 2-hr. lecture and conference meetings led by the production manager, the department superintendent, and the training supervisor.

In the first two meetings the production manager lectured on the principles and theory of organization, reviewed organization charts, and clarified functions, relationships, and policies.

In succeeding meetings the superintendent and his supervisors as a group identified duties of each position associated with the general responsibilities agreed upon.

One of the charts we reviewed in studying our organization structure was as below.

By organization structure is meant the relationships of the people involved, and their activities, to one another, and to the whole. The parts of the structure are the tasks, the jobs, or the functions, and the respective members of the personnel who perform or control them.



The above chart shows the activities of my papermaking organization divided into functional subdivisions, which we call departments; and it indicates the levels of supervision in each department and traces the relationships through the chain of command.

In the opening lectures and discussions, it was pointed out that the skill of building an effective organization is a specialized planning and training skill, and requires the recognition and use of certain guiding principles. The production manager interpreted some of these principles and explained how they applied to influence structure, relationships, and policy in the papermaking organization. Some of the principles discussed are: (1) *o*bjective, (2) *s*pecialization (functional grouping), (3) *c*oordination, (4) *a*uthority, (5) *r*esponsibility, (6) span of control, and (7) definition.

You will observe that the initial letter of the first five principles listed give you an *Oscar!*

The Principle of the Objective

With regard to the principle of the objective, Urwick has stated:

> "Every organization and every part of every organization must be an expression of the purpose of the undertaking or it is meaningless and therefore redundant."

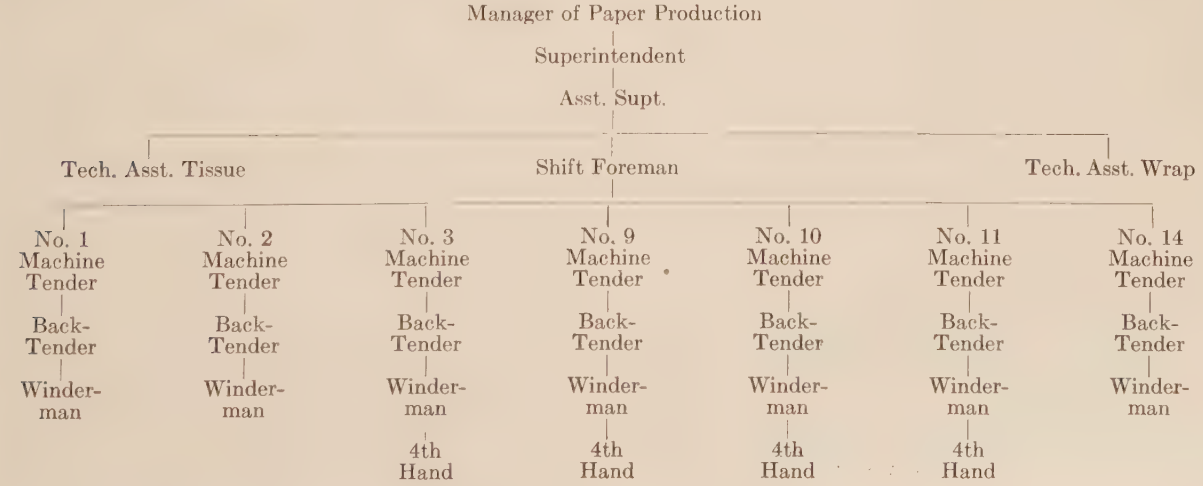
You cannot organize in a vacuum; you must organize for something. What do you want to accomplish with your organization? Make something? Sell something? Win an election? Build a road? Have a family???!

Our objective is to make and finish paper. We want to make the most of the best quality at the highest efficiency and least cost. That is what we are organized for!

The Principle of Specialization

According to the principle of specialization, the activities of every member of any organized group should be confined as far as possible to the performance of a single function.

The structure of the organization of our Tissue Paper Machine Department is as follows:



The division of our paper mill into "tissue" machines and "wrapping" machines, is an application of the principle of specialization. The appointment of technical assistants, to which are assigned specialized duties like slime control and special additive preparation, are other applications of the principle of specialization.

As our organizations grow in size and technical problems become more numerous and more difficult, the management job becomes more and more complex. To assist in getting better results it has been necessary to add to our organization's staff people who are specialists in many fields. Their advice and counsel give invaluable aid to operating personnel in such lines as forecasting, training, safety, costs, technical services.

The Principle of Coordination

A third important principle of organization is coordination. Simply stated, this means "unity of effort." Coordination requires good planning, a cooperative attitude, and effective communication.

We organize to combine the "economy of individual effort" (specialization) with the "unity of combined effort" (coordination).

The organization must permit, and promote, the best coordination. To draw an example from our business, assume that a paper machine is to be shut down for repairs and clothing changes. All who are familiar with a paper mill will know that to minimize costly down time and expedite good maintenance there must be the maximum of coordination of plan and action in the machine room, and between the paper machine department and other departments·

. . . with the maintenance department for pipefitters, millwrights, riggers, electricians, and other tradesmen
. . . with the beater room on furnish
. . . with the pulp mills re pulp supply
. . . with personnel to provide help
. . . with the order department re programming
. . . with the steam plant
etc., etc.

To facilitate coordination, our maintenance and operating supervisors hold short planning meetings each morning for the consideration of general maintenance work and work to be done during machine shutdown; and once a week a longer meeting is held to review all the work planned for that week. We have made mechanical coordination one of the major duties of one of the technical assistants.

The Principle of Definition

The next two principles of organization on our list are authority and responsibility. However, because of its application, let us first consider the principle of definition.

According to the principle of definition, "The duties and responsibilities of each position, and the relationships with other positions, should be clearly defined and made known to all concerned."

I mentioned to you earlier that in our organization building program we have developed "duty and responsibility guides." Meeting as a group, with all members encouraged to participate freely, the supervisors worked out together a listing of general responsibilities and associated duties of each position to discharge the responsibilities.

As a practical aid to thinking about the specific activities in a very complex supervisory relationship with a minimum of confusion and unnecessary repetition, the group concentrated their attention on one "phase" or "subject" at a time. Two of the phases, or subjects, the group chose to explore were production and housekeeping.

The duties of the superintendent, assistant superintendent, shift foreman, technical assistant, tissue and technical assistant—wrapping, were listed to discharge general responsibilities in relation to production.

Similarly, the duties of the group were listed for each position to discharge the general responsibilities under the subject of housekeeping.

Similar listings of general responsibilities and duties were developed in relation to other subjects such as safety, quality, costs, maintenance, training, records, etc.

As indicated earlier, this step of developing the duty and responsibility guides followed immediately after the lectures where our organization charts were reviewed and policies, principles, and relationships discussed. Throughout the development of the duty and responsibility guides, the applicable principles of organization and the related policies and relationships pertinent to our organization were kept in mind.

The Principle of Authority and the Principle of Responsibility

Let us look now at the interpretation of the principles of authority and responsibility.

Authority and responsibility go together and must always be in balance.

Authority is the formal right to require action of others.

In every organized group the supreme authority must rest somewhere. There should be a clear line of authority from the supreme authority to every individual in the group. The "chain of command" must be clear.

Authority is essential to an effective organization, but it is not a substitute for cooperation and coordination.

Everyone employed in any organized group is entitled to know:

1. Who is his boss?
   No man can serve two masters. It should be clear to each man to whom he is accountable.
2. How does his boss get his authority?
   What is the line of delegation from the supreme authority in the organization to his immediate boss?
3. That he will be supported in carrying out instructions from his immediate boss.

Responsibility is accountability for the performance of duties.

To effectuate responsibility, action is required. These actions, or things done, are called duties. Hence, duties are the activities which the individual holding a given position is required to perform by virtue of his occupancy of the position.

The guilding principle of responsibility may be stated: the responsibility of the superior for the acts of his subordinate is absolute.

By-passing the approved line of authority either upward or downward does not build teamwork or morale. Neither does buck-passing, nor alibis.

The Principle of Span

A sixth principle of organization is span of control.

Authorities differ on this point. Urwick states the principle that "no person should supervise more than five or six direct subordinates whose work interlocks." However, this rule may vary with the geography involved, the complexity of the functions, the nature of the people supervised, and other factors.

Too few in the span means too many layers, too little delegation of authority, and too much expense.
Too many in the span means inadequate supervision.

Our paper machines operate seven days a week. As shown on the chart, the superintendent, assistant superintendent, and shift foremen supervise seven paper machines. The standard work week is 5 days. When the superintendent is off, he is relieved by the assistant superintendent, and vice versa. They are together on the job only 3 days a week. However, when they are both here, the assistant can handle general operating, while the superintendent looks after special items, personnel, etc. This arrangement also enables the assistant superintendent to take care of special assignments on stock losses, clothing, water, steam, air, etc.

SUMMARY AND CONCLUSION

We have talked quite a lot about the "purpose and benefits" and the "how" of organization; now, let us turn our attention to summarizing and concluding these remarks.

I think that somewhere along the line we suggested:

- . . . that the job of management is to put together men, machines, and materials in a harmonious working relationship to best achieve the purposes of the enterprise
- . . . that fundamentally management is getting results through people
- . . . that to do this we must build an effective organization
- . . . that building an effective organization is essentially a planning and training job

I do believe that you can get more and better results through people by putting thought and time and effort into the planning and training essential to building up a well-balanced, smooth-running, purposeful organization.

With a sound organization, that very important ingredient teamwork can be obtained, and the men on the team will willingly assume the responsibility and authority necessary to reach the desired objectives.

A good organization provides clear-cut avenues for better communication within and between departments. It establishes the proper relationship for best cooperation and coordination.

A good organization provides for the proper assignments of responsibility and authority and establishes the proper relationship between a man and his superior. It promotes better supervision, facilitates training, and provides a way to develop the people in it to their highest potential.

Through proper organization the work load can be better distributed, which helps eliminate bottlenecks and results in increased production of higher quality.

Continued effort to build an ever-better organization results in improved plans, policies, and procedures, which are essential to systematic orderly growth.

Among other things, we have been able to convert one of

our most troublesome machines into a machine that runs with good spirit, at increased production and higher efficiency.

Our shift foremen are better able to plan and coordinate the job on shutdowns, and in many cases we have been able to substantially reduce wire change and machine wash-up and grade change time.

Since we have worked at our organization building program, our machine tenders have become better able and more willing to assume responsibility for the training and supervision of their crews. We have been able to better afford each man an opportunity to learn the job ahead and are now able to successfully let as many as 25 men go on vacation at one time (the time of their choice) without jeopardizing operations.

These have been some of my experiences—what have been yours?

Reducing Wood Waste

C. C. Heritage

The pulp and paper industry, especially the kraft industry, has contributed materially to better utilization, making the harvest from each acre produce more goods and more jobs and earn a satisfactory return on more invested capital. The growth of the pulp and paper industry from 17 million tons in 1940 to 31,000,000 in 1953 coupled with a great increase in wood value provided the favorable environment necessary to achieve this improved utilization performance. There appears to be no slackening of this growth rate in the foreseeable future.

The term waste means different things to different people. To the technologist, waste means something which is not used because one or more of the three vital conditions for use is lacking, namely, practical technology, sound economics, or the urge of necessity. When these three factors are favorable, a waste, as such, ceases to exist. Semichemical pulping of waste hardwoods was sound and economical almost 20 years before the urge of necessity put it over the top.

The term waste to the layman is more than something not used. The connotation is that there is carelessness and squandering. The lumber mills for many years were called wastrels and despoilers. Two developments are getting us out of that alleged category, namely tree farming and integrated whole-log use. The one means we use the forest land for the largest, best crop we can grow in the time available and the other means we harvest everything which sound silviculture will permit and process all of it as raw material to useful products. Let us first take stock of integrated whole-log use.

A log consists of bark and sound wood and may contain in addition, decay. We will reserve discussion of bark and decay until a little later. Use of sound wood falls in three categories: as wood, as fiber, and for chemicals. Whole, sound, barked logs have been and are being used in their entirety for fiber and in a few cases for chemicals. For use as wood, that is for lumber and plywood, complete whole-log use is to all intents and purposes impossible. If then we are to produce wood as wood but have whole-log use, integration of uses becomes imperative.

The pulp manufacturer has practiced whole-log use for years. Why should he be concerned about integrated utilization in order that lumber may be produced yet the whole log be used? He is entitled to a rational answer.

First, is lumber manufacture a continuing growing business which justifies so close a relationship as that involved in raw material integration? A continuing growing business depends in the main upon product performance relative to price. Lumber performance is highly satisfactory with respect to five out of seven basic requirements: appearance, durability, handleability, workability, and contribution to comfort. Notwithstanding there are improvements to be made in the other two, better permanence and uniformity, the utility per consumer dollar expanded is satisfactory to thousands of users. I am sure someone will ask, why is the per capita consumption decreasing? My view, if I may give it, is that per capita consumption of lumber passed through a minimum some 15 years ago and is now slowly increasing, too slowly I will admit. The earlier uses based on expediency have largely disappeared, those based on fundamental utility have now taken over.

I have often been asked why we do not grind up the whole log and synthesize lumber. From strictly a technical standpoint we are not within miles of being able to match the property values of wood at the density of wood, from wood fiber or any other raw material.

From a business standpoint the return on the investment for lumber compares favorably with other industries and other avenues of utilization. Capital required for manufacturing facilities is somewhat less than the annual sales volume generated, a very favorable situation. The manufacture of lumber is one of the most economic means of converting forest raw material to useful products. I feel very strongly that lumber manufacture is a continuing business of substantial growth potential, provided integrated whole-log use is practiced.

Second, the pulp manufacturer is entitled to ask what this whole log use, integrated with lumber, contributes to his business. Two answers are immediate, another lies in the future. The immediate answers are economic. Sawmill residual chips have in the past constituted the cheapest chip source, and in the future will no doubt be priced by supply and demand. It seems entirely reasonable to suppose that there will always be a margin compared to whole log chips to make residual chips attractive to the buyer. Integration of pulp with lumber at once brings logs into the sawmill which would not otherwise pay their way, increasing both lumber and residual chips. Third, the replacement of whole-log chips with residual chips puts more realization on the stump for future forest management, making the crop go farther for the same harvested area, and improving and increasing future crops.

It would be unfair not to mention that the pulp maker loses some flexibility and independence by integrating with lumber but he can always fall back on whole-log chips when necessity arises. On the other hand, the lumber and plywood manufacturer sometimes dislikes to foster such chip using products as container board, insulation sheathing, and hardboard. Regardless of likes or dislikes the growth of the use of residual chips in the last few years is *prima facie* evidence of its soundness. Lumber becomes the keystone of the integration and it is thus for the good of all to promote the manufacture and use of lumber whenever the opportunity presents itself.

The use of lumber residuals for pulp is by no means new, having been practiced over the years either by hand picking bark-free wood or by rossing the bark off the larger pieces, both methods expensive and unsatisfactory. Furthermore, in general, valuable lumber species were not valuable pulp species. So two developments were required, the pulping of lumber species and the barking of sawlogs. The sulphate process applied to western species answered the first. The hydraulic barkers answered the second but only for those lumber mills large enough to afford the high capital cost involved. The smaller mills were still without an answer.

In 1942 Weyerhaeuser development began to give attention to Douglas-fir bark utilization and being desirous of employing dry processing of the bark for the separation of cork, fiber, and powder for various sound reasons, it appeared to be justified to devise a dry barker, at that time for application to peeler logs. The principle selected after considerable experimentation involved mechanically breaking the bark bond at the cambium layer by compression and shear, and bulldozing off the bark so loosened. The first barker of this type was put into successful operation in the then new plywood plant of

C. C. Heritage, Weyerhaeuser Timber Co., Tacoma, Wash.

Longview branch in 1947 and furnished "as is" bark to the new bark plant that same year. Since that time this basic principle has been employed in various designs of sawlog barkers, of first cost well within the resources of the small sawmill. Although installations currently are relatively few in number, the trend is evident. Because of the very large number of small sawmills, some 60,000 in the United States, the chip potential from this source is indeed great, and is certain to become a major factor in cheaper lumber and pulp and the balancing of forest growth with drain.

Now let us look at the kind and amounts of these lumber residuals, assuming sawlog barking. The kinds do not vary much from mill to mill so long as kiln-dried lumber is the main product. The amounts vary widely depending on the quality of logs being sawed and in turn on the availability of integrated use. Rather than attempting to deal with such empirical measures as feet log scale and units of chips, I have used a materials balance based on percentage by volume of the incoming rough log, chosen because lumber is sold by volume; and have selected a hypothetical mill drying and surfacing 95% of the output. The following table presents two cases, case I a minimum of residuals as would be found in a non-integrated mill sawing sound good quality logs only, and case II a maximum of residuals as found after integration when appreciable amounts of wood and cull logs are processed.

Sawmill Materials Balance Based on Percentage by Volume (Solid) of Entering Logs

	Case I		*Case II*	
Bark		10		10
Green sawdust	12		16	
Green chippable	16		26	
Green residuals		28		42
Dry shavings	10		8	
Dry trims	6		4	
Dry residuals		16		12
Drying shrinkage		4		3
Finished lumber		42[a]		33
Total volume entering		100		100
Assumed average log: Gross cu. ft./MLS		150[b]		200
Assumed average log: Net cu. ft./MLS		150		150

[a] The corresponding figure for plywood is about 38%.
[b] An average log 24 in. in diameter 32 ft. long.

The residuals fraction with which we have been principally concerned for integrated use is the 16 to 26% of the incoming volume appearing as green chippable, which includes slabs, edgings, and trims. For hypothetical case I the gross scale of the logs is the same as the net scale. For hypothetical case II the gross scale exceeds the net scale by one third or 50 cu. ft. per M net scale. So the green residuals of case II gain volumewise both by virtue of this free wood and by a higher volume percentage of residuals.

If it is desired to convert any of the kinds of residuals to tons or to units per M log scale, this may be done by determining or assuming average log dimensions, hence volume in cubic feet and feet log scale, applying the proper volume percentage, and converting to air-dry weight using the usual species density figure. Thus green chippable case I shows 0.36 ton and case II 0.78 ton of chips per M net log scale. Actual figures in commercial practice will ordinarily lie somewhere between these limits.

The uses for these chips are legion from whole wood fiber to chemical cellulose, from hardboard to tissue. This brings me to mention the trend of increasing weight yields of fiber products for specific uses, without sacrifice of the utility of the product. It is clear that if less of the original wood than necessary goes out to the consumer, we are almost as guilty of waste as though we had not used the wood in the first place. High yield sulphite and high yield kraft, not to mention semi-chemical bleached and unbleached pulps, are well established. Yet to be exploited is the still higher yield area represented by the Forest Products Laboratories' cold caustic process and by fractionated or refined whole-wood defibrator fiber. There is much to be done in passing along more of the wood to the paper consumer while still satisfactorily complying with his requirements.

The soft and hardboards compete with pulp proper for these residual chips and hence merit brief reference at this point. Soft or insulation board had its expansion immediately after the war; hardboard expansion followed several years later. For these products the highest possible weight yields are being practiced. The most interesting innovation technically is continuous processing from chips to humidified hardboard without employing suspending water, allowing plants to be located without reference to water supply.

Defining residuals as those portions of the log not sold as products, what has been done about the 10% by volume of bark? Pacific Lumber Co. started its bark products business in 1931, Weyerhaeuser in 1947. Both are based on mechanical processing for physical uses. Speaking for Weyerhaeuser only, although the business is profitable and growing each year, it has not been possible to reach the large markets needed to consume thousands of tons annually, primarily because of high freight costs to the eastern industrial centers.

Bark as a chemical raw material began to receive serious attention about 10 years ago, and because the various commercial barks are an amazing source of organics, interest is now fairly widespread. Several companies have taken the initial steps by constructing pilot plants or small production plants. It has been our experience that separation of the chemicals from the lignocellulose of the hard tissue is easily done but the isolation of chemically like bodies in useful purity is difficult. I have no doubt but that a sizable bark chemical industry will evolve in due course. And raw material will not be in short supply.

The remaining sawmill residuals, namely green sawdust and dry shavings, sawdust, and trims, amounting to some 28% of the original rough log volume for either case I or case II, have not been of interest to the pulp maker because the fiber has been seriously cut and kiln drying brings about irreversible changes in wood quality. However, a sequence of developments now occurring is worth while mentioning.

Particle board, a product made by binding together nonfibrous particles of wood, has unique value because it comes closest to simulating wood itself without perpetuating the nonuniformities of wood. Early board-by-board processes employing sawdust were indifferently successful. The art has now progressed to continuous forming employing shavings, strands, or ribbons, either as produced by the lumber planer or as specially manufactured from pieces of wood. There are now a number of particle board plants in operation, and the evidence is that particle board is here to stay.

The attention to shavings utilization and particularly the availability of very thin vertical grain ribbons, flakes, or wafers has sparked interest in the continuous pulping of such particles since presumably the fibers therein have not been unduly cut. The pulps thus far made are encouraging. These events could well make basic changes in pulping processes, equipment, and raw material, all advantageous to a lumber-pulp integration either via mill residuals or forest residuals.

To utilize sawdust in large volume for substantial low priced markets, it would seem that we must come to grips with chemicals manufacture. We have no time to discuss this subject. Suffice it to say that there appear to be no insurmountable obstacles to commercialization of delignification, chemical fractionation, hydrolysis, or pyrolysis as applied to sawdust. The catch is that all of the raw material must appear as valuable products to achieve sound economics. When necessity arises one of these days we will have a chemicals-from-wood industry, if we have provided technology which is

practical. It is doubtful that we will ever have complete utilization of the tree crop until chemicals take their place as products.

I have thus far emphasized lumber-pulp integration by way of the mill residuals because economics dictate that these shall be used first. Equally important in the long run are the logging or forest residuals, and back of that the utilization of the full growth potential of the land.

What is happening to that very complex activity known as forest management, the business of regenerating a forest as quickly and completely as possible and bringing it to a maximum crop of the greatest value in the shortest time? Good forest management is almost wholly dependent on utilization and if this in turn is integrated as with lumber and pulp, many more avenues of good management are open to the forester.

Today more than ever, it pays to grow trees. The basic philosophy that trees are a crop, formally initiated 12 years ago, is finding wide acceptance. Certified tree farms now total upwards of 30 million acres, only a beginning but a good one. Certification is not just a gesture. The land is to be used for the production of commercial forest crops, a management plan must be formulated, and a source of competent management advice must be designated. The certification is canceled if these conditions do not obtain. The movement is entirely voluntary.

Many of us are not foresters but I think we can understand the complexity of establishing a reliable sustained yield program, one that safely capitalizes the full potential of the land, making due allowance for drain by fire, insects, and disease on the one hand; and for thinnings, future improvements in harvesting, and in utilization on the other. For example, the increasing use of mobile logging equipment and trucks operating on roads, minimizes topographical limitations, provides flexibility, decreases minimum log size, contributes greatly to the prevention and quick suppression of fire, and allows access to damaged timber which would otherwise be lost as inaccessible.

The major difficulty in using the full potential of the land, I think, lies in bringing oneself to take off the agreed upon full annual cut each year because there is always the tendency to play on the safe side. As experience accumulates, confidence will grow, and this waste will become smaller.

It appears logical at this point to mention briefly the utility of a lumber-pulp integration on the practice of thinning a growing immature forest to salvage those trees which would ultimately be crowded out and to release the remainder for higher yield at harvest. Thinning should constitute a substantial interim dividend for the tree farmer.

I am under the impression that thinning of our Pacific Northwest forests has not been extensively practiced perhaps because we have been too busy harvesting mature trees; and that the forester has much to learn about what to take and the logger how to take it. I had the privilege recently of visiting certain experimental forest areas under joint study by the Forest Service and private industry where the work is directed largely toward both the techniques and economics of thinning.

No matter how desirable it may be to thin a forest, this is unlikely to be done unless the thinnings constitute as cheap a form of wood as that currently used, or the demand for wood has arrived at that point where thinnings are the next cheapest variety. Consequently the problems of harvesting and transportation loom large. Yarding of full tree lengths using horses contributes to low cost and least damage to the stand. Bundling of the small trees further reduces costs. There are those who promote barking and chipping in the woods, or chipping rough with subsequent separation of bark. However, as a rule the cheapest place to apply power and labor is at the mill. Suffice it to say, there are many problems to be solved if the harvesting and use of thinnings is to be generally practiced.

Finally turning our attention to the make-up of the mature forest, what does lumber-pulp integration contribute to the allowable annual cut? First there is the matter of species. By inference at least the discussion has centered around Douglas-fir fortunately excellent for lumber and for sulphate pulp. Fortunately also the sulphate process is applicable so far as I know to any species including the deciduous ones. Actually the recent expansion of lumber-pulp integration is as much due to the versatility of the kraft process as to any other factor.

Integration between lumber and sulphite mills using western hemlock is less developed. The sulphite process had its greatest expansion in this area at a time when hemlock was in disfavor as a lumber species. The industry built its woodrooms around the reduction of logs and tended to become self-sufficient on this source of supply. Hemlock was more valuable for pulp than for lumber or at any rate there was too little to be gained to worry about integration. Consequently, we find at least until recently the sulphite mills converting large and sometimes high-grade hemlock logs into pulp chips.

The hemlock situation is now changing. There are sawmills of substantial size either in southwest Washington or in the foothills of the Washington Cascades which must depend upon hemlock for a major proportion of the annual cut. Those competent to judge, rate its value as high as any, when well manufactured and properly used. A program to build consumer demand is producing results. It is unfortunate that there is also an eastern hemlock which places the western species at a psychological disadvantage. A story is told of the late John Newlin, famous for his knowledge of timber mechanics. There was a great squabble on at the time between Douglas-fir and southern pine. John built a new home. He used western hemlock because as he said, it was by far the best buy. Although there is no question about the high quality of hemlock fiber, there is also little question now of the value of the clear wood portion of a hemlock log. The break-even point between pulp chips and hemlock lumber appears to be shifting toward lumber and as hemlock lumber becomes more widely accepted and clear Douglas-fir less plentiful, economics should throw high-grade hemlock more and more to the sawmill.

An opposite example recently occurred at Weyerhaeuser's Klamath Falls branch in the case of one of the white firs, *Abies concolor*. It is found in admixture with ponderosa or in fairly pure stands. It has been used to a limited extent for lumber. When decision was made to locate a hardboard plant at Klamath and use *Abies concolor*, which incidentally produces an excellent whole wood fiber, the question of lumber integration was settled in the negative because this species develops decay too early in its life to have put on sufficient clear wood to be profitable for lumber. There is at present no additional earning power to be gained by integrating lumber and hardboard at the manufacturing level. The gain takes place at the forest management level where it is large indeed.

The so-called mixed species problem in the Inland Empire had always been very troublesome on the basis of lumber alone. The problem I believe has been largely solved by the integrated manufacture of sulphate pulp. I think we need say no more on the question of species.

Now, without reference to species, let us look at a typical mature Coast forest area ready for harvest. We will clear cut leaving blocks of seed trees. What shall we take, what shall we leave? Under normal conditions with no integration the logger harvests and sends to market all trees which are of such size and quality as to yield a lumber profit, or, in the case of companies operating under a sustained yield policy, all trees and logs down to the break-even point. Thus, those logs and trees are left which are too small or too defective to be profitably converted into lumber.

There are two primary methods of lowering the break-even point on this type of material—improving the market and decreasing the cost of getting it to the market. Integration

via pulp is creating the demand which provides the market; the logger and the mills he serves are searching for and developing methods and equipment for reducing costs.

Let us consider first the problem of the tree too small to be profitably converted into lumber only.

Weyerhaeuser and others are pioneering in what has come to be known as prelogging. Under this system the logging is done in two steps; in the first one trees, say to a stump diameter of 20 in., are removed. Thus what would normally be broken and rejected during the logging of the large timber is utilized. The use of light mobile equipment reduces handling costs. Depending upon stand conditions, windfalls may be taken out. It has been found that prelogging reduces falling breakage in the large timber, thus contributing doubly to the more complete harvest.

In prelogging the trees are removed and transported in as long lengths as possible and the maximum tree diameter taken depends on the logger's analysis of the break-even point in costs, prelogging versus primary logging. Then the question of head rig versus chipper spout must be answered on the basis of the higher realization.

Relogging, following primary logging, has received some impetus as a means of making certain that everything economically useful has been taken, and appears practical when lumber-pulp integration is practiced. Pieces of trees variously described as toothpicks, tops and chunks and an occasional log constitute the assortment involved. Since this material may be almost any shape or size the difficulties of doing a low cost job are even greater than in the case of the other logging techniques.

In a mature forest many trees are very nonuniform quality-wise because of defects almost infinite in extent and pattern within the tree. The most common Douglas-fir defect is decay caused by the fungus *Fomes pini* which manifests itself as a honeycomb of pockets in each of which is a white mycelium, hence the common descriptive term of white pocket or white speck. The wood between the pockets is sound except in the very advanced stage of decay when other fungi destroy the connecting wood. Usually there is much sound wood in a "pini" log, often in the form of an outside shell of finest quality. Commercially known as cull logs,this material is all velvet because no self-respecting cruiser would tally such trees.

I am sure there must have been cases where a pulp mill or a sawmill or a plywood plant has operated on this type of raw material without integration, perhaps sparked by log shortages. However, it seems self-evident that a much more lucrative result can be stabilized by integrated use. Such is the situation at Weyerhaeuser's Springfield, Oregon branch, the forests being to a large extent overmature Douglas-fir. Sound sawlogs go to lumber; sound peelers to plywood; residuals to chips or fuel. Pini peelers go to plywood and to Ply-Veneer, a laminated product for panels and containers composed of a veneer core and kraft liners, residuals again to chips or fuel. Pini logs go to the sawmill for scalping of lumber with cants to pulp, or directly to pulp via a splitter to permit passage into the chipper spout. Sound blocks too short for lumber or plywood also go directly to splitting. Thus each log travels the route of greatest realization. And although it is difficult to believe, the branch is regularly buying hogged fuel on the outside. In addition, the pulp mill takes the chipped lumber residuals from Coos Bay branch 125 rail miles away.

I have made reference to loss of independence of action by the various elements in an integrated setup. Certainly slowing down a sawmill would inconvenience a pulp mill but slowing down a pulp mill would result in residual chips knee deep in short order. However, the growth curve for pulp compared with that for lumber makes such an eventuality seem rather remote.

On the other side of the ledger there is a less obvious flexibility in four directions, namely the extent to which prelogging and cull log production are practiced, the dividing line between logs to the sawmill and logs to the pulp mill, the dividing line between lumber residuals to pulp and to fuel, and the extent to which low grade green commons are diverted to chips. There is a constant play of economic forces controlling this flexibility and the balancing of operating conditions to meet circumstances is largely a matter of seasoned judgment.

To summarize: I think on the evidence it will be agreed that praiseworthy progress has been made in the reduction of wood waste. I shall not repeat the various accomplishments. The proof may be seen by anyone who will look. Compare the residuals left in the woods in 1939 with those remaining in 1954. If you didn't happen to be around in 1939, there is no dearth of photographs taken by those whose remarks were not too complimentary. At Weyerhaeuser's Longview branch 25,000 ft. per acre is the 10-year gain in harvest, not including cull logs, prelogs, and thinnings.

Burners are disappearing, I will admit too slowly. Pulp, container board, hardboard, and particle board are flowing from plants which have not required the cutting of a single additional acre of forest land.

For the future a recent writer tersely said, the forests are not so meager as to cause alarm nor so abundant as to justify complacency. We have many things to do. Get the small sawmills properly integrated with economical transportation and adequate markets for their tremendous potential of residuals. Put bark to work. Put sawdust to work. Get all the cull logs into appropriate plants. Make thinnings use economical. Keep the pulp yields increasing.

We have come a long way in the last decade but the economists tell us there will be 200,000,000 folks in 30 or 40 years hence, all working less and enjoying more than at present, so you young fellows still have a job to do that demands the best you have to offer.

New England

The annual meeting of the New England Section of the Technical Association of the Pulp and Paper Industry was held at the Oceanside Hotel, Magnolia, Mass., on June 11 and 12, 1954.

Mill visits to the Champion International Co. mill and the A & P Corrugated Paper Box Co. in Lawrence, Mass., were first on the program. Those visiting Champion inspected the soda pulp mill as well as the paper mill where high quality coated papers are made, and the others saw the newest board mill in New England at the A & P plant.

Following registration two papers were presented: "A Customer's View of Quality Control in Specialty Papermaking," by D. L. Boyd and "White Water Clarification Equipment," by Nicholas J. Lardieri. Both of these papers are published in this issue of *Tappi* following the meeting report.

On Saturday morning the Section's business meeting was held and the following officers were elected for the 1954–55 season:

Chairman—F. S. Klein, Byron Weston Co., Dalton, Mass.
Vice-Chairman—G. L. Benson, St. Regis Paper Co., East Pepperell, Mass.
Secretary-Treasurer—R. W. Ramsdell, Hercules Powder Co., Holyoke, Mass.
Executive Committee—Miss Helen U. Kiely, Northampton, Mass.; C. I. Horton, Norwalk, Conn.; J. T. Loomer, Robert Gair Co., Inc., Uncasville, Conn.; P. L. Haggerty, Geo. Lamonte & Son, Nutley, N. J.; C. L. Reese, Whiting Paper Co., Holyoke, Mass.; John Lewis, Lowell Technological Institute, Lowell, Mass.; Ronald Mallock, American Writing Paper Corp., Holyoke, Mass.; William Stillman, Bird & Son, Inc., East Walpole, Mass.

The remainder of the day was devoted to social events, finally concluding with the annual banquet at which about 100 were present.

R. W. Ransdell, *Secretary-Treasurer*

A Customer's View of Quality Control in Specialty Papermaking

D. L. Boyd

THERE has been an increasing interest in the use of statistical quality control not only as an inspection tool, but as a method of maintaining desirable manufacturing levels. A brief review of a few copies of *New England Tappi* has indicated that some very interesting papers have been presented on some of the techniques employed in the applications of statistical quality control.

I certainly do not want to present myself as an expert on the subject. My purpose rather is to tell how the application of some of the simpler methods has been very helpful in obtaining and maintaining those characteristics we consider desirable in filter paper for a domestic vacuum cleaner bag.

Air-Way Electric Appliance Corp. was the pioneer in promoting the disposable paper bag in a vacuum cleaner. We have used it continuously and, with few exceptions, exclusively since 1920 when the corporation was formed. The paper itself has been of the same general type, and has been largely identified with Air-Way. Some excellent patents, not only on the paper bag as such, but on the practical application to a vacuum cleaner as a dirt receiver, pretty well protected us from competition until the appliance boom following World War II.

Now practically every vacuum cleaner on the market, particularly of the "tank" or "canister" type offers disposable bags of widely differing types of paper. With but few exceptions these are really accessories since they are simply liners for a conventional cloth bag. In some cases they are quite frankly offered only as one of the opening wedges in a sales talk, and the customer is actually informed that their use is not required as the cloth bag alone is satisfactory.

For such applications, although it must be porous, the paper bag does not have to be a particularly good filter, nor does it have to have any exceptional qualities as far as tensile strength or tear resistance is concerned. Even cost of material may not be of too great importance since continual replacement is not required and the customer may be expected to pay a premium for the added convenience in emptying the bag.

On the other hand there are vacuum cleaners that employ no supporting cloth bag. Entire reliance is placed on the paper to do an adequate job of filtering and yet have the various strength requirements to support not only the load of dirt picked up, but also the stress of increasing air pressure as the pores are gradually closed. Another elusive problem that confronts the manufacturers of these cleaners is that of the customer with little or no mechanical ability. Some of these customers use some very weird methods indeed to replace a bag.

For this latter class of vacuum cleaner manufacturers, of which Air-Way was the original, the quality of the paper they employ in their bag is very important. One of the attractive sales arguments is that every time a dirty bag is replaced by a new clean bag the original efficiency of the cleaner is restored. The pores of any cloth bag gradually fill with dirt thus decreasing efficiency. Cost of replacement therefore becomes very important. The manufacturers of these cleaners face the problem of furnishing a bag with the necessary filtering, strength, and convenience characteristics at a price the customer is willing to pay at regular intervals. Of course, they all like to make a little profit on this service.

Specifications on material probably vary rather widely among the different manufacturers judging from the different types of paper used. However, it seems reasonable to suppose that they all cover important characteristics such as basis weight, tensile strength, both with and cross machine direction, and tear resistance. Some specification covering porosity and filtering ability is no doubt included. In certain instances further characteristics such as stretch, burst, stiffness, impact resistance, and so on may be specified.

Once the individual manufacturer has set up his paper specifications, his problem and that of his supplier is to see that he gets what he wants. In other words how will they inspect the product to their mutual satisfaction.

For every characteristic covered in a specification there must be a mutually agreed upon method of measurement. For most characteristics TAPPI has a satisfactory specification covering measurement. For certain characteristics, the vacuum cleaner manufacturer may have measurements methods not covered by TAPPI because of the real or implied very special nature of the characteristic. In such cases the apparatus used and the methods of measurement must be clearly defined and mutually acceptable to both parties.

There are several methods that may be used by the vacuum cleaner manufacturer to insure that the paper he is getting is according to his specifications. He may sample check the material as he receives it. This may be long after the paper has been made, particularly if he has the paper shipped to an intermediate party who makes his bags for him. It may be further complicated if this intermediate party ships directly to distribution points and only sends a small portion directly to the cleaner manufacturer's home plant. Paper is somewhat like ammunition. That which is tested is of no further use. At best only a small per cent can be tested, but the procedure as outlined above materially reduces this percentage.

Sometimes the cleaner manufacturer sends an engineer to the paper manufacturer's plant to observe the tests made during the routine run. Since these runs usually last over 24 hr., he is not in on every test. A casual review of data taken in his absence may be reassuring, but he may still rely mainly on tests by attributes at his own plant.

In other words reliance has been placed on inspection by attributes, although that term has only been popularized comparatively recently. Military Standard 105-A used so widely by the armed forces covers this method of assuring quality of product very adequately. Scientific methods replace formerly somewhat haphazard sampling. Such methods protect the vacuum cleaner manufacturer from accepting faulty material, but they do not help the paper manufacturer until it is too late.

The alternate method is to use continuous sampling by variables. I think everyone is somewhat familiar with this procedure. Briefly it involves taking samples at regular intervals during the run and testing these samples for the specified characteristics.

Successive regular groups of successive individual results on each observation are averaged, and this average together with the difference between the highest and lowest value within the group, known as the range, recorded. The application of very simple mathematical rules determines whether or not the betting odds are good or bad that the product is holding within specification. A little further application of simple mathematical rules will give some indication at least as to what percentage of the total run will be below specification limits, or conversely how much exceeds specification.

At the risk of boring you with monotonous repetition of former papers the following description of the method of sampling by variables employed by Air-Way and our paper manufacturer is given. A sample, the width of the machine and several feet long, is taken from each reel of paper as it is produced. Each of the mutually agreed upon variable characteristics is carefully measured for each sample and recorded. If only one reading for a given characteristic for each sample is considered sufficient, that reading is taken as the X for the sample. On certain characteristics it may be desirable to take several readings across the machine direction. In this case we have chosen to take the average value as the X for the sample. Incidentally we have not found too wide a variation across the sheet for which we give the paper manufacturer a lot of credit.

D. L. BOYD, Chief Engineer, Air-Way Electric Appliance Corp., Toledo, Ohio.

As five successive samples are accumulated, their average value, or bar-X ($\bar{X}$) is calculated as well as the difference, or range, R, between the highest and the lowest values in the group of five.

As long as these average values and ranges fall within certain predetermined values we know that the paper is coming within specification. If they do not come within these limits we know that the process must be changed, or that we are going to have to reach a mutual agreement to accept a certain per cent of the paper out of specification.

The degree of statistical control maintained in any single run can be determined, and compared to control limits set up from experience. The grand average for a given variable or double-bar-X ($\bar{\bar{X}}$) is obtained by averaging all of the bar-X's obtained for the run. The average range for the run is the average of the ranges calculated for each successive group of five. This average range is called bar-R ($\bar{R}$).

For purposes of determining satistical control, upper and lower control limits for values of bar-X are calculated as well as an upper control limit for the range R. The control limits for bar-X are obtained by multiplying the average range for the run, bar-R, by 0.58. The value thus obtained is added to the double-bar-X figure to obtain the upper control limit on bar-X, and subtracted to obtain the lower control limit. The figure 0.58 only applies when groups of five are used. Other factors to be applied for groups of different individual numbers may be obtained from any book on statistical quality control.

The upper control limit on range is obtained by multiplying the bar-R, or average range value by 2.11. The lower control limit is zero since it is perfectly reasonable to have five successive readings alike. Again the factor applies only to groups of five individual readings.

Whether or not all bar-X values lie in between the upper and lower control limit for R determines whether or not the run is in consistent statistical control in itself. The degree in which the particular run meets specification is determined by how well the values lie within the over-all control limits set up for the process.

In our particular case, we had a pretty good idea of what was desirable in the various characteristics. We also had some idea as to how widely the values for the various characteristics had varied over the years with paper supplied by several different manufacturers. These ideas were obtained by reviewing the accumulated data for more or less haphazard sampling tests. I cannot call such tests scientific sampling by attributes since in the old days no record was kept as to what percentage of the product was sampled. We did, however, do a little sampling from most of the runs, and quite a number of records were available.

Therefore, in setting up a new source of supply a little over a year ago, we wrote up a set of specifications based on wishful thinking tempered by the knowledge of variations experienced in the past, and painful memories of the loud and long complaints from the field resulting from defective paper. These specifications were frankly discussed with the new supplier, and modified in certain respects by mutual agreement.

All of the data taken during each run is submitted to us by the supplier. Most of the time we have a representative present during the run, but not always. The bar-X and R values, double-bar-X and bar-R values, and the control limits are calculated for each run. The cumulative values of the above were run out considering all runs for the first year as one grand lot. Both Air-Way and the supplier feel that such a grand lot demonstrates the control possible over each of the variables. Therefore the control limits of the grand lot have been chosen as the control limits to be adhered to in future runs. We both are hopeful that with increased knowledge and experience they can be narrowed down and all characteristics improved.

As long as the various bar-X and R values lie within their established control limits, we know, and the paper manufacturer knows, that the amount of substandard paper in the run is negligible. He knows that when a point goes out of the established limits trouble is brewing and some action should be taken. Air-Way can determine with some assurance what the risk is in accepting all of the paper, or if the risk is too great, can say without fear of contradiction that certain reels are not acceptable.

As a check on the above procedure, our supplier has furnished us with out-turn samples from representative reels from each run. Our laboratory tests these not only shortly after receipt, but at intervals representing differing temperature and humidity conditions. Unfortunately vacuum cleaners do not operate under controlled temperature and humidity conditions. We also do a limited amount of sampling by attributes of completely manufactured bags. Our results of these added tests have confirmed the reliability of the method of sampling by variables at the time of manufacture.

Summing up, application of statistical quality control by variables enables the paper manufacturer to know at all times whether or not his product will meet specification. It is sensitive enough to warn him promptly if his basic materials or process are not up to standard, or if his mill men are not on the job. This can save the paper manufacturer a lot of scrap and the vacuum cleaner manufacturer a lot of headaches. Above all it saves arguments between the two.

I am sorry that I cannot properly credit the author who so appropriately stated that the success or failure of any statistical quality control program depends on the following five M's in order of descending importance: (1) management, (2) measurement, (3) machine, (4) man, and (5) material. Unless the managements of both supplier and customer can be convinced that such a program will work there is no use attempting it. It must be possible to measure adequately any given characteristic by methods mutually agreed upon by supplier and customer. That the supplier thinks he has the proper machines, the qualified men to run them, and the proper material for the manufacture of the product is obvious. His problem is to control these elements. To do this he must continuously know how they are behaving.

I read the other day in a trade journal that "statistics are like Bikini bathing suits—what they show is suggestive, what they hide is vital." Our objectives are to use all the suggestions for action to get the vital facts out in the open where they can be dealt with.

White Water Clarification Equipment

Harry W. Gehm and Nicholas J. Lardieri

Four main benefits are usually derived from the clarification of paper mill white water: (1) recovery of fiber and filler, (2) recovery of water which may be used in various mill processes, (3) alleviation or prevention of stream pollution, and, (4) savings of heat through reuse of warm waters.

Simplification of mill flow sheets often is an incidental advantage derived from this treatment. While the ultimate objectives of white water clarification are similar in most mills the application of a uniform white water treatment system in the paper industry is impossible due to the variety of materials and processes employed. Required end-product quality also usually places many limitations on the type and degree of recovery and reuse possible. It is the purpose of this discussion to briefly review the principal types of white water clarification equipment and their applicability to various papermaking processes.

Certain basic factors must be considered in the selection, installation, and operation of any white water clarification

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system. Segregation or collection of the waters to be treated in most cases requires some degree of repiping and flowsheet changes. Measurement of flows and waste concentration are essential and it is especially important to determine peak volumes and the degree of variation to be expected as these materially affect the operation of any treatment system. Other determinations should include: nature and amount of solids present and required chemical dosages where this type of treatment is to be employed.

Success of any white water clarification system after installation is dependent on its adjustment to specific mill conditions. Operation must be correlated with such factors as flow, type, and concentration of influent solids, pH, temperature, and reuse of effluent and recovered stock. Optimum conditions can only be determined, therefore, after a sufficient period of full-scale plant operation under careful control. While the degree of maintenance and supervision required by different systems varies, none of these units are "self-operating"; efficient results may only be obtained by continued and close surveillance.

WHITE WATER CLARIFICATION METHODS

Sedimentation

In general, sedimentation units used in the paper industry are of two basic types: plain settling tanks or basins and mechanized clarifiers with automatic sludge collection or thickening mechanisms.

All types of sedimentation devices should attempt to achieve the following: (1) passage of the liquid through the unit at a uniform velocity with a minimum of disturbance to allow practically complete subsidence of settleable solids, and (2) collect, thicken, and remove sludge at a rate high enough so that it does not interfere with sedimentation or slime-up and can be discharged at a desirable consistency with respect to its disposition.

Probably the most important single factor influencing sedimentation is flow. Effective results cannot be obtained if tank velocities exceed limits at which particle subsidence will take place. Adequate capacity should be provided, therefore, and the tanks designed to obtain quiescent conditions particularly at inlet and outlet ends. Use of recirculated effluent often aids in establishing uniform flow which beneficially affects sedimentation efficiency.

Sedimentation is advantageous for white water treatment in regards to cost as is shown in Table I. These units are easy to operate due to their low sensitivity and simple construction. Pretreatment is usually limited to screening and de-aeration may be required in some cases. Effective results are usually obtained at low solids concentration but performance is only fair with high solids at reasonable overflow rates. Reuse of both effluent and stock are limited due to these variable results. Higher efficiencies can be obtained with chemical coagulation but only at a rise in cost and in some cases increased sludge disposal problems.

Table I. Characteristics of White Water Clarification Equipment

Type	*Flotation*	*Filtration*	*Reactor*	*Settling*
Common makes →	*Sveen Colloidair Gibbs Savalla*	*IMPCO Oliver Bird Waco*	*Infilco H.-T. Co. Cochran Allis-Chalm.*	*Hardinge Marx Link-Belt Dorr*
Space requirements	Low	Low	High	High
Detention time	Low	Low	High	High
Pretreatment	None	None	Required	Required
Relative cost	1.3	1.5–2.5	1.5	1.0
Maintenance cost	Low	High	Low	Low
Operating cost	1	2	3	4
Chemicals required	Yes	No	Yes	No
Sensitivity	High	Low	High	Low
Sweetner stock	Optional	Required	None	None
Performance—high solids	Good	Good	Poor	Fair
Performance—low solids	Good	Good	Good	Good
Reuse of effluent	Limited	Wide	Limited	Limited
Reuse of stock	Good	Good	Variable	Fair

Disposal of white water residues is generally accomplished by lagooning the underflow or dumping it after dewatering; in either case high consistency is desirable. Vacuum filtration requires a minimum consistency of 5% for good filtration and to a certain point, filter loadings increase with feed consistency. Hence, the thicker the underflow discharged to the filter the smaller the unit needed or operating period required.

Sludge Contact Reactors

These devices which are essentially sedimentation units operate on the principle of upward flow through a blanket of suspended solids formed from material separated from the white water. This blanket acts as a filtering medium in removing the solids in the upflowing water. Sludge may be concentrated in the reactor or in a separate unit and is bled off continuously.

Satisfactory operation with low solids waters is obtained if adequate capacity is provided. Chemical addition is necessary and space requirements are high. The main disadvantage of these units are their sensitiveness to flow, temperature, and solids concentration changes. With high solids waters there is a tendency for the sludge blanket to form too rapidly, often resulting in a loss of solids over the weirs. The reuse of stock is variable because of poor sludge compression which results from the fact that settling and flotation are proceeding simultaneously.

Filtration

The various filtration mechanisms used for white water clarification usually depend on the formation of a cellulose mat through which the water is filtered. Filtration treatment has several distinct advantages: (1) chemicals or flocculating agents are not necessary; (2) space requirements are low; (3) uniform results are obtained as large variations in solids content of the feed have only a minor effect on efficiency (this uniformity permits wide reuse of effluent and stock); (4) stock concentration is high (5 to 15%).

It is necessary, in most cases, to add at least 25 lb. per 1000 gal. of "sweetner stock" to the water before filtration in order to obtain a retentive mat. This long-fibered pulp which is usually paper machine furnish is recovered with the separated materials for reuse in the papermaking process.

Filtration is the most expensive of the white water clarification methods. Operating and maintenance costs of this type of equipment are also relatively high.

Flotation

Flotation of white water solids is based on the theory of paper sizing as developed by Lorenz (*1*) with the exception of air injection in the incoming white water. When aluminum sulphate (alum) is dissolved in water positively charged aluminum hydroxide is formed which acts as an "electrostatic cement" between the coagulant and cellulosic materials which are negatively loaded when dispersed in water. Use of materials such as rosin size, glue, "pitch," aid in making the solid particles in the water sticky so they will better adhere to the air bubbles introduced.

Excellent solids reductions are obtained over a wide range of influent concentration in property operated units. Since the recovered stock is concentrated from 2 to 4%, efficient reuse is possible. Effluent reuse is somewhat limited due to the sensitivity of the flotation process. Minor variations in pH, temperature, and flow often result in a loss of clarification efficiency. Recirculation of clarified effluent is now often practiced in an attempt to smooth these fluctuations.

Space requirements for flotation treatment are low but the amount of supervision necessary and the operating costs are relatively high.

APPLICABILITY OF WHITE WATER CLARIFICATION METHODS

As has been stated previously the diverse nature of white waters and product requirements means that individual mill analyses be made before the selection of any white water system. The characteristics of white waters resulting from the manufacture of a particular type of paper product are similar enough to permit the generalizations shown in Table II. This table shows the various treatments that have been found successful to a greater or lesser degree in clarifying white waters. Final choice of any system will depend on space and economic considerations in addition to water and stock requirements.

White waters from news and chip manufacture have been efficiently treated with all of the main types of devices which have been discussed. Tissue white waters are not amenable to conventional sedimentation due to the hydrous nature of the long fibers which settle slowly. Flotation savealls are especially adapted to these waters as the fiber is collected in a high concentration and returned rapidly to the system at a relatively low total cost.

Table II. Applicability of Clarification Methods to Various Types of Papermaking

Product mfd.	*Flotation*	*Filtration*	*Reactor*	*Settling*
News and chip	+	+	+	+
Tissues	+	+	+	−
Filled papers	+	−	+	+
Long fiber prod.	+	+	−	−
Insulating board	−	+	−	−
Press boards	−	−	+	+
Rag rope jute	+	+	+	+
Pulping wastes	−	+	−	−

Until recently flotation was almost exclusively used for the clarification of filler paper white waters. In addition to the normal flotation chemicals (alum, glue, etc.) fiber must often be added to insure a sufficiently high fiber to filler ratio. This is necessary to allow adherence of filler and to maintain a balance in the slurry returned to the machine. Upflow reactor units are now being given some attention but there seems little reason to believe that they will prove any more satisfactory than the flotation units. Filtration is not efficient for these waters due to the large quantities of fines which plug the mat thereby materially reducing the length of filter runs.

The buoyant tendency of solids in waters from the manufacture of long fibered products makes flotation treatment ideal. Filtration may also be applied successfully due to the high percentage of long fibers present. The light, hydrous nature of the solids prevents the effective use of conventional sedimentation units.

Insulating board waters contain a mixture of very coarse and fine solids which may most easily be removed by filtration. Difficulties are encountered in sedimentation units by the failure of the finer particles to adequately settle in reasonable detention times. In the case of press board manufacture the addition of pigments such as carbon black and ferric oxide results in large quantities of fine, dense solids in the white water. These fines which clog filtration mats and are too heavy to be fully removed by flotation are readily and inexpensively removed by sedimentation.

All types of treatment have been used to treat rag, rope, and jute wastes while the large quantities of fiber usually present in pulp wastes make filtration most desirable.

LITERATURE CITED

1. Niberger, B., and Bedette, R. E., *Tappi* 32: 572 (1949).

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UNITED STATES PATENTS ON PAPERMAKING

First Quarter, 1954

Compiled by W. B. Weber

THE following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the Gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired.

January 5, 1954

Ahlborn, Clarence E. Pulp press. U. S. patent 2,664,814. Filed Feb. 21, 1948. 11 claims. Assigned to Jackson & Church Co. [Cl. 100-117.] Conical hub with conveyor vanes is rotated inside a perforated cylindrical shell. As the pulp is forced downward by the vanes, it is progressively confined between the hub and the shell until forced through the adjustable annular opening at the bottom.

Asplund, Arne J. A. Vibrous filter sheet for gases. U. S. patent 2,664,964. Filed July 16, 1947. 3 claims. [Cl. 183–44.] Asplund fiber is formed into a sheet for filtering dust particles from air or other gases. Bonding agent is impregnated into the sheet.

Baumann, Martin. Shipping container. U. S. patent 2,665,050. Filed June 1, 1950. 1 claim. Assigned to International Paper Co. [Cl. 229–33.] Extensions from the end walls form reinforcements for the side walls in this container for bottled goods.

Baumann, Martin, and Sider, Nicholas M. Shipping package. U. S. patent 2,665,002. Filed June 1, 1950. 1 claim. Assigned to International Paper Co. [Cl. 206–46.] Method of assembling and securing top and bottom sections for a large package such as a refrigerator carton.

Belsinger, Jack R. Shipping container for heavy bulk merchandise. U. S. patent 2,665,047. Filed Nov. 8, 1950. 1 claim. Assigned to Belsinger, Inc. [Cl. 229-14.] Top and bottom sections telescope over a liner to make a container suitable for nails and the like.

Belsinger, Samuel P. Heavy-duty fiber container. U. S. patent 2,665,048. Filed March 23, 1950. 2 claims. Assigned to Belsinger, Inc. [Cl. 229-27.] Four folded blanks are combined to form this double-compartment container for eggs, fruit, and the like.

Bradley, Theodore F. Sizing of fibrous materials and compositions useful for sizing and for other purposes. U. S. patent 2,665,206. Filed June 15, 1948. 10 claims. Assigned to Shell Development Co. [Cl. 92-3.] Lubricating oil emulsions with salts of naphthenic acids are precipitated on the fiber by acidic precipitants such as alum.

Cook, Ernest P. Multilength continuous doctor blade. U. S. patent 2,664,792. Filed Sept. 27, 1949. 6 claims. Assigned to Brown Co. [Cl. 92-74.] A coilable strip of metal is drawn back and forth through a blade holder while the drier drum is in operation, the strip operating between a pair of reels while grinding wheels regrind the doctoring edge for each pass of the blade.

Corney, Harold D. Wrapped tire. U. S. patent 2,665,001. Filed May 2, 1950. 1 claim. Assigned to United States Rubber Co. [Cl. 206-46.] Method of wrapping an automobile tire with a paper strip.

Dunlap, Charles K. Means for sizing and surface finishing paper tubes and the like. U. S. patent 2,664,793. Filed March 21, 1950. 12 claims. Assigned to Sonoco Products Co. [Cl. 93-83.] Paper tubes (e.g., textile yarn carriers) are impregnated with thermosetting resin, turned down to proper diameter, and cured in a heated curing die in this machine.

Feigelman, Herman A. Combined display card and articles thereon. U. S. patent 2,665,003. Filed Jan. 25, 1951. 1 claim. [Cl. 206-79.] Objects held thereon form a part of the design of this counter display card.

Ferrari, Ernest R. Machine for splitting or resawing insulating boards. U. S. patent 2,664,923. Filed Oct. 14, 1952. 3 claims. Assigned to American Smooth Saw Co. [Cl. 143-5. Beveled boards are cut from regular insulation board by a slightly modified bandsaw.

George, Walter C. Partitioned folded-blank bottle carrier. U. S. patent 2,665,049. Filed Sept. 23, 1949. 2 claims. Assigned to Gaylord Container Corp. [Cl. 229-28.] Bottle carrier.

Grangaard, Donald H. Process for impregnating cellulosic sheet. U. S. patent 2,665,221. Filed July 7, 1950. 4 claims. Assigned to Paper Patents Co. [Cl. 117-60.] Control of moisture in the paper web and in the water-soluble, phenol-aldehyde-type resin is claimed to produce impregnated sheets of improved characteristics.

Katzman, Abe. Partitions for boxes, cartons, and the like. U. S. patent 2,665,026. Filed Nov. 30, 1949. 3 claims. [Cl. 217-22]. System for packing long-necked bottles within a carton is claimed.

McMillan, Frank, M., and Sullivan, Robert D. Naphthenate sized products. U. S. patent 2,665,207. Filed June 29, 1948. 6 claims. Assigned to Shell Development Co. [Cl. 92-3.] Kraft pulp is sized with naphthenic acid or a naphthenate with an acid number over 200, then the sizing agent precipitated on the fiber with alum.

Pauley, Robert D., and McCanna, Louis A. Apparatus for removing bark from logs. U. S. reissue patent 23,765. Filed May 11, 1953. 19 claims. Assigned to Weyerhaeuser Timber Co. [Cl. 144-208.] Blunt tool is held against bark with compressive force while the log is rotated.

Simons, Howard A. Hydraulic log-barker having log-hold-down rollers and confronting rotary spray heads. U. S. patent 2,664,929. Filed March 17, 1953. 17 claims. [Cl. 144-208.] Barker claimed to be effective for small logs.

Tomarin, Harry A. Combination shirt wrapper and collar support. U. S. patent 2,665,051. Filed April 4, 1950. 1 claim. Assigned to Loroco Industries, Inc. [Cl. 229-87.]

Zimmerman, Frederick J. Waste disposal. U. S. patent 2,665,249. Filed March 27, 1950. 9 claims. Assigned to Sterling Drug, Inc. [Cl. 210-2.] Compressed air is pumped through waste effluent material (e.g., spent sulphite liquor or kraft liquor) at pressures of 1500 p.s.i. and temperatures of 480 to 625°F. in a self-sustaining oxidation from which heat is recoverable.

January 12, 1954

Anglada, Joseph A. Reinforced package wrapper. U. S. patent 2,665,834. Filed Sept. 7, 1949. 4 claims. Assigned to American Viscose Corp. [Cl. 229-7.] Regenerated cellulose wrapper is provided with reinforcing strips of the same material.

Bakalar, Arthur B., and Sullivan, Robert D., Method of sizing paper. U. S. patent 2,665,983. Filed Aug. 2, 1948. 12 claims. Assigned to Shell Development Co. [Cl. 92-3.] Water-in-oil emulsions are stabilized by the addition of a polyphosphoric acid compound, then precipitated on the fiber by addition of an acidic material such as alum.

Bergstein, Robert M. Lined box structure. U. S. patent 2,665,835. Filed Nov. 27, 1948. 4 claims. [Cl. 229-14.] Window top carton with cellophane lining and window covering.

Brunner, Ernst, and Hindes, Frederic W. Optical bleaching agents containing two 1:2:3-triazole rings. U. S. patent 2,666,062. Filed Jan. 11, 1952. 12 claims. Assigned to The Clayton Aniline Co. Ltd. [Cl. 260-308.] Optical brightening agent.

Busch, Thomas N. Bark-removing drum combined with hydraulic jet. U. S. patent 2,665,721. Filed Sept. 26, 1952. 7 claims. [Cl. 144-208.] Series of independent drums may be rotated at different speeds and hydraulic nozzles (located in the narrow space between drums) aid in bark removal.

Forrer, Homer W. Carrying device for bottle carriers. U. S. patent 2,665,838. Filed May 15, 1950. 3 claims. Assigned to Atlanta Paper Co. [Cl. 229-52.] Wire handle for carrying two carriers at once.

Galbraith, Martin J. Grease and moistureproof carton and container. U. S. patent 2,665,833. Filed April 15, 1949. 4 claims. Assigned to Sutherland Paper Co. (Cl. 229-3.1.] Hy-

drogenated vegetable oil is impregnated into the carton blank to prevent oil penetration.

Guyer, Reynolds. Carton. U. S. patent 2,665,837. Filed May 19, 1948. 3 claims. Assigned to Waldorf Paper Products Co. [Cl. 229-37.] Small tips are left at the ends of the flaps to ensure a siftproof closure at the corners.

Jungmayr, Theodor. Method of manufacturing boxes. U. S. patent 2,665,616. Filed May 10, 1952. 1 claim. [Cl. 93-55.1.] The closure blank is sealed into the bottom section of the carton by a thermoplastic foil layer in the sealing zone.

Koester, Melvin C. Shipping container for glass sheets. U. S. patent 2,665,804. Filed Dec. 7, 1951. 8 claims. Assigned to Libbey-Owens-Ford Glass Co. [Cl. 206-62.] Central partitions and end cushioning inserts hold the sheets out of contact with the container walls.

Niks, Nicholas J. Apparatus for manufacture of paper. U. S. patent 2,665,615. Filed Jan. 12, 1949. 3 claims. [Cl. 92-44.] Headbox and slice arrangement around a fourdrinier machine breast roll with several adjustments for controlling sheet formation.

Rendall, Warren C. Produce tray. U. S. patent 2,665,836. Filed Jan. 10, 1951. 2 claims. Assigned to Gaylord Container Corp. [Cl. 229-32.] Solid or corrugated board trays contain end flanges that extend above the side wells for ventilation when attacked.

Ribich, Thomas A. Air control mechanism for pneumatic sheet separators. U. S. patent 2,665,907. Filed Sept. 6, 1950. 3 claims. Assigned to Weldon Tool Co. [Cl. 271-57.] An air blast directed at the forward edge of the stack lifts the top sheet while a vacuum wheel above the stack feeds sheets individually onto the conveyor.

Searle, Robert F. Paste applicator for paper bag sleeves. U. S. patent 2,665,661. Filed Aug. 18, 1950. 4 claims. Assigned to Arkell and Smiths. [Cl. 118-243.] Foot-treadle controlled device applies paste to a single sheet as required.

Sternfield, George L., and Block, Myron W. Disposable cleansing tissue. U. S. patent 2,665,528. Filed Jan. 27, 1950. 2 claims. [Cl. 51-185.] Wet-strength paper or cloth-base sheet is coated with adhesive material to retain finely divided abrasive media and soap or detergent compounds.

Tillery, Hubert B. Garment hanger guard. U. S. patent 2,665,829. Filed March 31, 1953. 4 claims. Assigned to Tillery Container Co. [Cl. 223-98.] Paperboard or plastic pants guard.

Wood, Wayne A. Carton closing machine. U. S. patent 2,665,532. Filed Sept. 14, 1950. 7 claims. Assigned to Sutherland Paper Co. [Cl. 53-147.] Machine for closing hinged-cover cartons containing bakery goods.

January 19, 1954

Bachus, Benson F. Fourdrinier type machine for applying pulp insulation to wires. U. S. patent 2,666,370. Filed Aug. 20, 1948. 8 claims. Assigned to Western Electric Co., Inc. [Cl. 92-44.]

Beachler, Edward D. Suction press assembly. U. S. patent 2,666,371. Filed Sept. 27, 1950. 2 claims. Assigned to Beloit Iron Works. [Cl. 92-49.] Series of suction press rolls and felts carry the web from the wire to the Yankee drier drum.

Collins, Ernest H. Method and apparatus for measuring moisture content. U. S. patent 2,666,897. Filed June 28, 1948. 14 claims. Assigned to Weyerhaeuser Timber Co. [Cl. 324-65.] Heating elements incorporated in the electrodes of the instrument raise the temperature of the test specimen to a point where electrical conductance is affected by moisture content. In the example, 300°F. is given for wood veneer.

Davis, Austin E. Preparation of sheet material with remoistenable gum coating. U. S. patent 2,666,718. Filed May 25, 1950. 5 claims. Assigned to Nashua Corp. [Cl. 117-122.] Porous gummed surface readily moistenable is made by controlled evolution of gas within the gum layer during drying.

Dearborn, Ernest R. Wrapping machine for irregularly curved articles. U. S. patent 2,666,283. Filed Oct. 19, 1951. 14 claims. Assigned to Angier Corp. [Cl. 53-104.] Wrapping tape is wound around an irregular object such as an automobile bumper by a rotating ring shuttle which follows the convolutions of the article.

Farrell, Robert A. Interfitting lock. U. S. patent 2,666,567. Filed April 10, 1950. 3 claims. Assigned to Marathon Corp. [Cl. 229-45.] Locking flaps for paperboard cartons are easily closed by machine.

Frommer, Joseph C. Web centerline control device. U. S. patent 2,666,639. Filed May 14, 1951. 5 claims. Assigned to Electric Eye Equipment Co. [Cl. 271-2.6.] A pair of sensing elements, operating on either side of the web, are interconnected to move toward or away from the centerline simultaneously and energize the proper circuits to return the web to alignment if a lateral shift is detected.

King, Glengarry D., and Harkema, Russel V. Method of making masked lignocellulosic material. U. S. patent 2,666,726. Filed April 21, 1951. 1 claim. Assigned to Crown Zellerbach Corp. [Cl. 154-106.] Resin impregnated sheet is bonded to the surface of plywood to mask defects and provide a hard, durable finish.

Lang, Louis, and Baird, Ronald J. Plasticizer and moisture retentive composition for paper and paper containing it. U. S. patent 2,666,713. Filed Feb. 8, 1950. 16 claims. Assigned to The National Sugar Refining Co. [Cl. 106-162.] A mixture of a sugar, urea, and a glucoside imparts moisture retention properties as well as grease resistance to the paper.

Lauffer, Jacob R. Automatic counting and tabbing machine for presses. U. S. patent 2,666,372. Filed May 2, 1950. 9 claims. Assigned to Hills-McCanna Co. [Cl. 93-93.] A tab cut from a supply roll is inserted in the stack of finished sheets after each unit of 50, 100, or 500 sheets delivered to the stack. The tabbing device is portable and may be moved from press to press and appropriate electrical connections made.

McQuiston, Raymond C., and Davenport, Frank E. Precipitating size with chromium and aluminum salts. U. S. patent 2,666,699. Filed Jan. 6, 1947. 4 claims. Assigned to Minnesota Mining & Manufacturing Co. [Cl. 92-21.] Deposition of latex or resins in colloidal form upon fibers before the fibers are made into sheets is claimed to produce materials suitable for shoe inner soles, gaskets, etc.

Mulnix, Ersel C. Carton. U. S. patent 2,666,566. Filed Oct. 14, 1948. 4 claims. [Cl. 229-39.] Bottle carrier.

Niks, Nicholas J. Method of making soft papers adaptable to impregnation. U. S. patent 2,666,369. Filed May 29, 1952. 2 claims. [Cl. 92-38.] Free water is drained from the sheet on the wire by suction and infrared heating of the web, as it is carried on a supporting felt, removes the major portion of the residual water. The sheet is not subjected to any pressing or compacting and is claimed to have an open, porous structure ideally suited to impregnation with various agents.

Robinette, Willard C. Paper web guide. U. S. patent 2,666,598. Filed May 5, 1950. 13 claims. [Cl. 242-76.] Tiltable, laterally displaceable idler roll actuated by a sensing element adjacent to the edge of the web is employed to eliminate shifting of the feed roll.

Staege, Stephen A., and Pearson, John H. Paper machinery. U. S. patent 2,666,368. Filed Oct. 14, 1950. 19 claims. Assigned to The Black-Clawson Co. [Cl. 92-27.] Control unit for plug-type refiners makes necessary adjustments in the plug setting to maintain a constant load on the refiner motor and may also be made sensitive to running characteristics of the stock on the paper machine.

January 26, 1954

Amatel, Harold. Package of fragile articles. U. S. patent 2,667,267. Filed May 17, 1949. 1 claim. Assigned to Westinghouse Electric Corp. [Cl. 206-65.] Package for three electric light bulbs.

Feyrer, William F. Packaging apparatus and method of packaging. U. S. patent 2,667,019. Filed Feb. 12, 1949. 33 claims. Assigned to Nathan L. Solomon. [Cl. 53-11.] Items mounted on a card are secured to the card by adhesive-coated tape and the tape pressed into contact with the card at selected points by pressing elements.

Hesse, Jack E. Method for manufacture of fiber-cement sheet laminates. U. S. patent 2,667,107. Filed Aug. 2, 1950. 7 claims. Assigned to Johns-Manville Corp. [Cl. 92-38.] Oversupply and recycling of asbestos-cement slurry to the forming cylinder is claimed to produce a more uniform sheet.

Hyman, Howard D., and Root, Edward M. Paper machinery. U. S. patent 2,667,106. Filed Sept. 13, 1951. 8 claims. Assigned to The Black-Clawson Co. [Cl. 92-20.] High pressure nozzles cut broke entering a pulper into narrow strips to prevent balling in the pulper.

Kauffman, John H. Packaging and dispensing frozen beverage forming concentrates. U. S. patent 2,667,422. Filed July 9, 1952. 13 claims. [Cl. 99-171.] Beverage concentrate is frozen into the bottom of a paper cup and the nested cup above utilized as a seal to prevent deterioration during storage.

Lovekin, Louise G. Disposable diaper. U. S. patent 2,667,168. Filed Oct. 4, 1951. 3 claims. [Cl. 128-284.]

McReary, Ronald. Handled carton for bakery products and the like. U. S. patent 2,667,297. Filed April 3, 1950. 2 claims. [Cl. 229-44.]

Monks, Frank E. Band forming machine and process. U. S. patent 2,667,108. Filed Oct. 8, 1948. 16 claims. Assigned to Fuller Label & Box Co. [Cl. 93-79.] Machine forms bands for bottle-neck labels from heat-sealable material by using air pressure to form the label around the mandrel.

Parker, Clarence E. Sheet handling apparatus. U. S. patent 2,667,259. Filed Sept. 1, 1951. 2 claims. Assigned to The Coe Manufacturing Co. [Cl. 198-33.] Alternate plasterboard panels are inverted on the following panel on the conveyor so that

the face sides of the pair of sheets are protected during subsequent handling.

Pauley, Robert D., and McCanna, Louis A. Method of barking logs. U. S. reissue patent 23,776. Filed May 11, 1953. 15 claims. Assigned to Weyerhaeuser Timber Co. [Cl. 144-309.] Pressure applied to the bark by a blunt tool while the log is rotated causes separation of the bark from the wood.

Simpson, Henry A. Packaging, storing, and vending frozen concentrates and the like. U. S. patent 2,667,423. Filed Oct. 5, 1951. 14 claims. [Cl. 99-171.] Very similar to U. S. patent 2,667,423 (Jan. 26, 1954).

February 2, 1954

Carpenter, Joseph E. Condensation products of higher fatty acids, polyalkylene polyamines, and organic halides. U. S. patent 2,668,165. Filed Dec. 22, 1951. 18 claims. Assigned to American Cyanamid Co. [Cl. 260-97.5.] Tall oil fatty acids form the base for this condensation product useful as a wetting agent for textiles, lubricants, and the like.

Chien, Luther C. Castor oil soluble coloring composition for coating copying paper. U. S. patent 2,668,172. Filed July 16, 1952. 4 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 260-388.] Victoria pure blue BOC dye is prevented from crystallizing out of hot castor oil by the addition of 4–5% of the sodium salt of dibutyl-*o*-phenyl-phenol-disulphonic acid to the coating composition.

Christman, Paul. Wallboard tape. U. S. patent 2,667,822. Filed Sept. 6, 1951. 2 claims. Assigned to Bemiss-Jason Co. [Cl. 93-1.] Method of manufacture for a paper tape.

Fennell, Francis L. Bleaching chemical paper pulp. U. S. patent 2,668,095. Filed Sept. 22, 1950. 9 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 8-106.] An acid wash between the hypochlorite and the alkaline peroxide stage in pulp bleaching is claimed to result in a pulp of improved brightness.

Grettve, Karl E. L. Apparatus and method for creping paper. U. S. patent 2,667,910. Filed Dec. 22, 1949. 6 claims. [Cl. 154-30.] Paper or foil to be creped is brought into contact with the tensioned outer surface of an elastic band as it passes over a small diameter roll and the creped paper separated from the band as tension is relaxed.

Jones, Tom L. Valve bag. U. S. patent 2,668,003. Filed June 3, 1950. 4 claims. Assigned to Arkell and Smiths. [Cl. 229-62.5.] A transverse slit in the side flap and an elongated inner ply serve to guide the filling nozzle and provide a more effective valve closure.

Lindquist, John R. Papermaking processes. U. S. patent 2,668,111. Filed March 5, 1952. 8 claims. Assigned to Certain-Teed Products Corp. [Cl. 92-21.] Guanidine formaldehyde is added to the furnish to coagulate latex or resin emulsions on the fibers without reducing the pH as is the custom when alum or like material is used.

McArn, Theodore A. Automatic cutoff for paperboard machines. U. S. patent 2,667,821. Filed Feb. 18, 1950. 4 claims. Assigned to Downingtown Manufacturing Co. [Cl. 92-67.] Knife blade is forced by double-acting air cylinder into a slot in the accumulator roll without interfering with rotation of the roll. Thickness of the stock controls actuation of the knife.

Mallabar, Herbert J. Manufacture of decorative laminate. U. S. patent 2,668,124. Filed Oct. 31, 1951. 6 claims. Assigned to Oxford Corp. [Cl. 117-15.] Cover sheet is coated, printed, impregnated with suitable resin, then laminated to the backing of plasterboard, fiberboard, or the like.

Spencer, Arthur M., Jacobson, Abner, and Sixt, Karl. Method for fiber liberation in cotton stalks and the pulp. U. S. patent 2,668,110. Filed June 18, 1948. 4 claims. Sixt's interest assigned to Spencer and Jacobson. [Cl. 92-6.] Wetting agent with dilute alkali is employed to liberate fibers from cotton stalks using a specially designed digester.

Taylor, Nelson W., and Clark, Bryce L. Heat-sensitive copying paper. U. S. patent 2,668,126. Filed Jan. 5, 1950. 4 claims. Assigned to Minnesota Mining & Manufacturing Co. [Cl. 117-36.] Infusible particles (e.g., glass beads) 3 to 4 mils in diameter mixed with a fusible wax coating, forms a heat-sensitive material easily separated from the original and cheaper than a coating made entirely of wax.

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Arneson, Edwin L. Bottle carrier. U. S. patent 2,668,653. Filed Feb. 12, 1949. 8 claims. Assigned to Morris Paper Mills. [Cl. 229-28.]

Back, Leonard. Transfer mechanism for sealing means. U. S. patent 2,668,708. Filed April 28, 1950. 15 claims. Assigned to The Interstate Folding Box Co. [Cl. 271-49.] Rubber belts under tension are used to move bag tubes of cellophane or other flexible material through machine operations.

Barefoot, Jocie C. Stop motion apparatus for wrapping machines. U. S. patent 2,668,404. Filed June 1, 1949. 5 claims. [Cl. 53-29.] Sensing elements establish the presence of both the item to be wrapped and the sheet of wrapping material at the start of each wrapping cycle and stop the machine if either is not in position.

Bate, Stanley C., Peach, Francis G., and Rogerson, Walter A. Production of cellulose. U. S. patent 2,668,761. Filed April 27, 1950. 11 claims. Assigned to British Celanese Ltd. [Cl. 92-9.] Chloracetic and glacial acetic acids in a diluent such as xylene or nitrobenzene is employed for pulping to produce a high-quality cellulose. Pulping agent is recovered by precipitation of lignin followed by solvent extraction.

Burger, Martin. Egg carton set-up device. U. S. patent 2,668,482. Filed May 23, 1950. 18 claims. Assigned to General Package Corp. [Cl. 93-37.] Manual device for setting up paperboard egg cartons.

Dills, William L. Process for flameproofing textile materials. U. S. patent 2,668,784. Filed Sept. 4, 1951. 6 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-138.] Titanium and antimony oxides are dissolved in an acidic aqueous solution containing an organic solvent.

Droll, Joseph W. Mattress winding and wrapping machine. U. S. patent 2,668,405. Filed Jan. 29, 1951. 12 claims. Assigned to Meridan Corp. [Cl. 53-52.] Mattresses are wound in a spiral about a mandrel and covered with paper from a supply roll.

Freel, William G., and Jones, Samuel F. Carton. U. S. patent 2,668,654. Filed Dec. 11, 1947. 3 claims. Assigned to William P. Frankenstein. [Cl. 229-31.] Double-walled carton made from a blank with only one finished surface, and this surface exposed throughout the carton.

Gold, Heinrich, and Petersen, Siegfried. Whitening agents for organic materials. U. S. patent 2,668,777. Filed Oct. 5, 1949. 8 claims. Assigned to Farbenfabriken Bayer Aktiengesellschaft. [Cl. 117-33.5.] Optical brightening agent derived from a stilbene and containing several 1,2,3-triazole rings per molecule is claimed.

Jackson, Donald R. P. Wrapping or packing machine. U. S. patent 2,668,406. Filed Aug. 27, 1951. 1 claim. Assigned to Molins Machine Co., Ltd. [Cl. 53-131.] Block-ended wrapping for cigarette package or the like.

Larsson, Olof E. Apparatus and process for corrugating paper. U. S. patent 2,668,573. Filed March 9, 1948. 6 claims. [Cl. 154-30.] Smooth feed rolls force the sheet into a restricted passage between plates set apart that establish the height of the finished corrugations. Friction of the paper against the plates impedes passage and causes the corrugations to be formed.

Panik, Irene M., and Sullivan, William F. Method for rendering cellulosic material fire resistant. U. S. patent 2,668,780. Filed Nov. 27, 1951. 4 claims. Assigned to National Lead Co. [Cl. 117-62.] Continuation in part of U. S. patent 2,658,-000 (Nov. 3, 1953) except that the partial drying step of the titanium chloride acetate-antimony chloride gel is carried out at temperatures up to 60°C.

Perry, Eugene L. Corrugated packing sheet. U. S. patent 2,668,786. Filed June 22, 1949. 1 claim. Assigned to Packaging Materials Corp. [Cl. 154-55.] Molded pulp packing sheet formed with corrugations.

Pettrorossi, Joseph. Decorative article. U. S. patent 2,668,-385. Filed Nov. 1, 1951. 1 claim. Assigned to Paper Novelty Manufacturing Co. [Cl. 41-11.] Article forms a pair of cellular paper Christmas bells or the like.

Robinson, Paul C. Machine for manufacturing valve bags. U. S. patent 2,668,481. Filed Oct. 29, 1948. 4 claims. Assigned to Arkell and Smiths. [Cl. 93-8.]

Russell, Henry R. Egg carton. U. S. patent 2,668,652. Filed May 19, 1948. 2 claims. Assigned to General Package Corp. [Cl. 229-15.]

Schlienz, Ralph W. Paper package and method of manufacture. U. S. patent 2,668,769. Filed Sept. 27, 1951. 5 claims. Assigned to Riegel Paper Corp. [Cl. 99-171.] Envelopes for holding pulverulent materials or small articles are made by joining two webs together along an overlapped edge to form the opening flap, the edges of the envelope formed and sealed in the usual manner.

Schramm, August F., Jr. Method of making a bonded permeable article. U. S. patent 2,668,787. Filed Jan. 9, 1951. 6 claims. [Cl. 154-92.] Fabric, paper, felt, etc. is made water repellent without interfering with vapor passage by dusting finely divided thermoplastic resin on the surface, then consolidating same to the base sheet by heat and pressure.

Segre, James. Apparatus for molding corrugated asbestos-cement sheets. U. S. patent 2,668,574. Filed Feb. 7, 1952. 4 claims. [Cl. 154-30.] Corrugated asbestos-cement sheets are formed between metal platens of nonuniform thickness to avoid the thin sidewall formation obtained with platens of uniform thickness.

Winters, William P. Sheet feeding and slitting machine with

strip feeding device. U. S. patent 2,668,591. Filed May 24, 1951. 6 claims. Assigned to American Can Co. [Cl. 164-61.] Metal or fiber blanks are slit and fed onto a stepped platform from which they are removed singly by feed dogs on a chain conveyor.

Wolfe, Henry J. Winding machine. U. S. patent 2,668,675. Filed Aug. 6, 1948. 6 claims. Assigned to National Gypsum Co. [Cl. 242-56.] Continuous web of material such as wallboard joint tape is wound into consumer-type rolls and the end of the roll sealed with a strip of gummed tape.

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Archibald, Frederick R. Methods of preparing flotation reagents. U. S. patent 2,669,545. Filed July 5, 1951. 5 claims. Assigned to United States Steel Corp. [Cl. 252-61.] Fatty acids such as tall oil, when mixed with sodium silicate and passed through an acid-type ion exchange column forms a flotation agent useful in separating iron oxide particles.

Baxter, Joseph, Jr. Paper machinery. U. S. patent 2,669,-165. Filed July 10, 1950. 10 claims. Assigned to The Black-Clawson Co. [Cl. 92-20.] Stock is fed between rapidly rotating brushes where the bristles act to tear the fiber bundles apart and release the fibers. Defibered stock may be discharged against a wire-covered drum from which the fiber is thrown in one direction and the water in another.

Behl, John D. Machine for erecting double side walls on double walled cartons. U. S. patent 2,669,167. Filed Dec. 3, 1952. 16 claims. Assigned to Sutherland Paper Co. [Cl. 93-49.] Double walls are folded and erected by beveled rollers acting in pairs as the blank is conveyed through the machine.

Benz, Johannes. Apparatus for packaging plastic materials. U. S. patent 2,669,077. Filed Aug. 24, 1951. 8 claims. [Cl. 53-95.] Small machine for limited production comprises an oscillating mold which first is lined with a prefolded package, then is filled with butter or other semisolid and the package ejected.

Bouchard, Orezul. Log-barking machine having a gimbal mounting for toothed log-feeding wheels. U. S. patent 2,669,-266. Filed June 7, 1951. 4 claims. [Cl. 144-208.] Logs are rotated by a toothed feed wheel which also advances logs past rotating knives.

Grenier, Joseph A. R. Egg carton. U. S. patent 2,669,380. Filed June 23, 1952. 2 claims. [Cl. 229-7.] Paperboard egg carton.

Kerr, Ralph W., and Katzbeck, Walter J. Cold water dispersible starch sizes and process of making them. U. S. patent 2,669,523. Filed Aug. 28, 1952. 14 claims. Assigned to Corn Products Refining Co. [Cl. 106-213.] Starch is oxidized with a hypochlorite, peroxide, or similar material, and the product heated and dried.

Kreyling, Robert L. Laminating adhesive and manufacture of combined fiberboard therewith. U. S. patent 2,669,282. Filed June 21, 1950. 19 claims. Assigned to Philadelphia Quartz Co. [Cl. 154-33.05.] Silicate adhesive with starch and finely divided siliceous material added is very rapid setting at 70–80°C. and does not limit machine speeds.

MacGregor, Donald W., and Griffith, Thomas R. Lignin-reinforced rubber. U. S. patent 2,669,592. Filed Aug. 24, 1951. 9 claims. Assigned to Howard Smith Paper Mills Ltd. [Cl. 260-756.] Kraft or soda lignin from hardwoods or softwoods incorporated into rubber with an oxide results in improved strength and resilience.

Olson, Douglas J. Plate provided with depending gripping means. U. S. patent 2,669,379. Filed Aug. 3, 1950. 2 claims. [Cl. 229-1.5.] Parts of the rim are bent down to hold between the knees of the user.

Ormsby, James W. Apparatus for packaging articles. U. S. patent 2,669,076. Filed Aug. 31, 1950. 10 claims. [Cl. 53-91.] Open-end, sleeve-type cartons with can-engaging flaps at either end are erected and filled by this machine.

Peterson, William R., and Penrod, William R. Apparatus for closing paper bags. U. S. patent 2,669,201. Filed Nov. 3, 1950. 10 claims. Assigned to St. Regis Paper Co. [Cl. 112-11.] Cam-shaped elements lift and smooth the bag wall just ahead of the stitcher.

Podgursky, John. Receptacle for filing papers. U. S. patent 2,669,381. Filed July 26, 1949. 3 claims. [Cl. 229-77.] File folder is equipped with locking tabs so it may also be used for mailing envelope.

Proppe, George W. Paper bag having flap with reinforced locking tongue and ticket retainer. U. S. patent 2,669,382. Filed April 29, 1952. 6 claims. Assigned to Equitable Paper Bag Co., Inc. [Cl. 229-84.] Locking tongue formed from a double thickness of the bag wall holds a ticket or strip of paper in view on the bag front.

Smith, Charles C. Method of making asbestos-cement sheets. U. S. patent 2,669,166. Filed Aug. 16, 1949. 1 claim. Assigned to The Ruberoid Co. [Cl. 92-40.] Modification of a Hatschek machine wherein a continuous web of asbestos-cement is slit, laminated with a cement-asbestos filler, pressed, then cut to board size.

Spitz, Isidor. Composite packaging or wrapping material and manufacture thereof. U. S. patent 2,669, 258. Filed Sept. 14, 1948. 10 claims. Assigned to American-National Bag & Burlap Co., Inc. [Cl. 138-55.] Burlap is stitched or adhesively secured to creped or crinkled paper and the composite wound into a bag tube in spiral form with stretchability in any direction.

Steinhardt, David W. Method of restoring used color-reactant record material for reuse. U. S. patent 2,669,503. Filed June 23, 1951. 9 claims. Assigned to The National Cash Register Co. [Cl. 8-102.] Eradicator fluid for manifold record materials using crystal violet lactone and attapulgite clay [U. S. patent 2,548,364 (April 10, 1951)] restores the color-sensitive surface to its original condition.

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Allan, John, and Thomas, Edward B. Process for the production of fibrous webs. U. S. patent 2,670, 316. Filed July 18, 1950. 2 claims. Assigned to British Celanese Ltd. [Cl. 154-136.] Web is impregnated with water-soluble, then water-insoluble, alcohol-soluble synthetic resin and the assembly pressed with heat to form a laminate.

Baxter, James C., and French, John H. Shipping tube with integral end closure. U. S. patent 2,670,129. Filed March 24, 1950. 3 claims. [Cl. 229-93.] Flaps on the ends of the tube interlock to form a closure for this paperboard tube.

Buchmiller, Earl P., and Cohen, Harold. Paperboard serving tray. U. S. patent 2,670,124. Filed Jan. 16, 1952. 4 claims. [Cl. 229-27.] Tray for holding food and cups of beverages.

Dahlstrom, Roy, and Bronson, George E. Method for the production of a fire-retardant solution. U. S. patent 2,670,297. Filed May 31, 1951. 5 claims. Assigned to National Lead Co. [Cl. 106-15.] Material claimed contains antimony trichloride and titanium tetrachloride and is sufficiently stable to withstand extended storage.

Davidson, George W., Kupfer, Allen M., and Kilmer, Charles B. Corner pad. U. S. patent 2,670,122. Filed March 22, 1952. 2 claims. Assigned to Container Corp. of America. [Cl. 229-14.] Corrugated board is folded so that a protecting layer is formed by the pad on three corner surfaces.

Frankenstein, William P. Carton. U. S. patent 2,670,123. Filed July 28, 1949. 10 claims. [Cl. 229-27.] Partitions are cut from the blank and, when erected in the double-walled carton, are held in place by notches in the side walls.

Frankenstein, William P. Carton. U. S. patent 2,670,125. Filed March 19, 1948. 15 claims. [Cl. 229-31.] Single blank is folded to make a carton with double side walls, end walls, and bottom.

Frankenstein, William P. Carton. U. S. patent 2,670,126. Filed Feb. 24, 1949. 14 claims. [Cl. 229-31.] Double-walled carton with sloping inner walls for better display of contents is claimed.

Gibson, Albert G. Apparatus for thickening liquid slurry stocks. U. S. patent 2,669, 909. Filed June 15, 1950. 8 claims. Assigned to The Black-Clawson Co. [Cl. 92-42.] Compartmented roll mounted in the overflow of a cylinder mold thickener meters the amount of dilute stock passing the overflow and therefore consistency of the thickened stock.

Gigler, Wilferd C. Machine for sealing cartons. U. S. patent 2,670,027. Filed Feb. 3, 1951. 3 claims. [Cl. 154-42.]

Gleason, Augustus W., and Bowles, Henry M. Folded end-panel carton. U. S. patent 2,670,127. Filed June 8, 1950. 4 claims. Assigned to California Research Corp. [Cl. 229-37.] Hexagonal container with flap extension of the side walls which fold inwardly to close the carton. Especially for packaging hot asphalt.

Golden, Samuel. Greeting card package and display container. U. S. patent 2,670,074. Filed Oct. 24, 1952. 4 claims. [Cl. 206-45.31.] Cardboard package with windows for view of the card.

Goodwillie, John E., and Hornbostel, Lloyd. Apparatus for removing liquids from perforated rotating shells. U. S. patent 2,669,912. Filed May 13, 1949. 5 claims. Assigned to Beloit Iron Works. [Cl. 92-53.] Air under pressure is introduced into the inside of the roll to force water in the perforations to the outside for collection, thus preventing reintroduction into the press felt.

Haegele, Otto P. Paper article of headwear. U. S. patent 2,669,725. Filed Sept. 1, 1950. 2 claims. Assigned to White Castle System, Inc. [Cl. 2-197.] Paper cap.

Hoag, Roderick W. Method and machine for filling and wrapping packages. U. S. patient 2,669,814. Filed Aug. 22, 1952. 5 claims. Assigned to Hoag-Russell Corp. [Cl. 53-10.] Packets formed from a corrugated web secured to a wrapper web are filled and sealed by this device.

Hunter, Melvin V., and Segesser, John R. Low melting paraffin wax. U. S. patent 2,670,323. Filed Jan. 6, 1951. 6 claims. Assigned to California Research Corp. [Cl. 196-149.] From

20 to 35% of nonstraight-chain paraffin wax incorporated in a straight-chain paraffin wax produces a wax of high tensile strength with a melting point between 125 and 135°F.

Irmsher, Hans O. Carton contents tamping and sealing apparatus. U. S. patent 2,669,813. Filed Jan. 26, 1950. 15 claims. Assigned to National Tea Packing Co., Inc. [Cl. 53-6.] Reciprocating plunger compacts articles within a carton before the closing and sealing operations.

Othmer, Donald F., and Smith, Warren R. Method of preparing molded products of lignocellulose and lignin. U. S. patent 2,669,522. Filed Dec. 16, 1950. 2 claims. [Cl. 106-123.] Commercial lignin is added to comminuted wood or other lignocellulosic material to a total of 33 to 40% and the composition molded under heat and pressure.

Pearson, Herschell R. Log loading boom. U. S. patent 2,670,177. Filed April 7, 1951. 4 claims. [Cl. 254-184.] Winch system incorporated in the boom design enables the normal crane winch to handle heavy loads. Supporting cable rigged to the boom from a spar tree prevents the crane from tipping.

Priest, Lester. Rewinding machine. U. S. patent 2,670,152. Filed March 3, 1950. 6 claims. Assigned to McLaurin-Jones Co. [Cl. 242-66.] Blade device attached to the head roll bearing blocks tucks the paper between the mandrel and the bed rolls to eliminate manual tucking and assure a smooth even start.

Stowitts, Frank H. Carton. U. S. patent 2,670,128. Filed Aug. 15, 1947. 3 claims. Assigned to Michigan Carton Co. [Cl. 229-38.] Siftproof carton with flaps that insure a tight seal at the corners.

Toulmin, Harry A., Jr. Composition for producing wrinkle-textured films. U. S. patent 2,670,337. Filed July 9, 1951. 1 claim. Assigned to New Wrinkle, Inc. [Cl. 260-31.2.] Thermoplastic resin dissolved in a solvent with a high rate of evaporation is coated on a base of metal, glass, paper, etc. and dried by infrared heating to a wrinkled finish.

Trotman, William E. K. Cylinder mold for use in papermaking. U. S. patent 2,669,910. Filed Aug. 8, 1950. 9 claims. [Cl. 92-43.] Grooved T-bars replace the usual rod and winding-wire construction for support of the wire on a cylinder mold. Grooves in the bars leave numerous small areas which support the wire cover.

Troy, Arnold I. Disposable filter and holder. U. S. patent 2,669,995. Filed April 28, 1950. 9 claims. [Cl. 131-10.] Cigarette filter made from spirally wound metal foil and absorbent paper also forms a holder for the cigarette.

Ungar, Gustave A. Apparatus for making honeycomb cores for sandwich-type structures. U. S. patent 2,670,026. Filed Feb. 1, 1952. 14 claims. Assigned to Douglas Aircraft Co. Inc. [Cl. 154-1.8.] A strip of kraft paper or fabric is impregnated with phenolic or other resin, then scored, slotted, and adhesive applied in certain areas before the web is fan-folded and heated to cure the resin and set the adhesive.

Ungar, Gustave A. Method for making honeycomb cores for sandwich-type structures. U. S. patent 2,670,314. Filed March 18, 1948. 18 claims. Assigned to Douglas Aircraft Co., Inc. [Cl. 154-117.] Similar to U. S. patent 2,670,026 (Feb. 23, 1954).

Zinn, Julius A., Jr., and Shaw, Curtis B. Method of an apparatus for closing and sealing containers. U. S. patent 2,669,815. Filed April 19, 1950. 23 claims. Shaw's interests assigned to Zinn. [Cl. 53-20.] Containers with fully depressable bellows-type end closure are preheated with heat lamps, then the seal completed by heated rolls which engage the flaps as the carton is conveyed through the machine.

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Bach, John W. Sheet feed control device. U. S. patent 2,670,954. Filed March 9, 1951. 14 claims. Assigned to Pitney-Bowes, Inc. [Cl. 271-57.] Sensing element forming a nip with the feed roll stops the feed roll if two sheets enter the nip simultaneously.

Bergman, William E. Use of ion-exchange materials for removal of scale deposits. U. S. patent 2,671,035. Filed Nov. 16, 1948. 5 claims. Assigned to Phillips Petroleum Co. [Cl. 134-7.] Zeolite or similar ion exchange materials are circulated through the equipment as a slurry to remove scale formations. Particle size is adjusted for easy flow and filterability.

Curtis, Russell H. Disposable liquid filter element. U. S. patent 2,670,851. Filed June 7, 1949. 6 claims. Assigned to Hawley Products Co. [Cl. 210-120.] Conical-shaped, molded filter elements made from kraft pulp, cotton linters, or the like and treated with wet-strength resin may be used single or stacked to provide increased filtering surface.

Dworak, Joseph R., and Busch, Rudolph H. Saucer pad. U. S. patent 2,670,615. Filed Oct. 6, 1950. 1 claim. [Cl. 65-16.] Absorbent paper is laminated to metal foil to make either an absorbent pad or an insulating cover.

Ensslin, Kurt, and Rathert, Hermann. Process for the production of porous foils from viscose. U. S. patent 2,670,500. Filed Aug. 8, 1950. 10 claims. Assigned to Vereinigte Glanzstoff-Fabriken A.G. [Cl. 18-47.5.] Viscose with cotton or hemp fiber added is pressed between smooth plates to form synthetic chamois of controlled porosity and thickness.

Heitmann, Hans. Machine for the production of envelopes, flat paper bags, and the like. U. S. patent 2,670,664. Filed May 13, 1950. 2 claims. [Cl. 93-62.] Precut blanks are printed, gummed, and dried while the direction of work travel is changed several times to conserve floor space.

Huck, William F. Tensioning mechanism for moving webs. U. S. patent 2,670,907. Filed Aug. 25, 1947. 3 claims. Assigned to Huck Co. [Cl. 242-75.] A variable diameter pulley interconnected with the driving means and the tension belt that rides on the surface of the web roll, keeps the roll under tension whether the web is winding or unwinding.

Kendrick, Marron. Package for lock sets. U. S. patent 2,670,892. Filed Aug. 18, 1950. 3 claims. Assigned to Schlage Lock Co. [Cl. 229-15.] A pair of mated trapezoidal cartons are contained within an outer rectangular paperboard carton.

Ranseen, Mauritz C. Card supporting device. U. S. patent 2,670,916. Filed Feb. 16, 1950. 12 claims. [Cl. 248-35.] Easel device with back-folding flaps to support the device and the attached cards.

Schur, Milton O., and Levy, Robert M. Process of producing calcium carbonate. U. S. reissue patent 23,794. Filed April 29, 1953. 4 claims. Assigned to Ecusta Paper Corp. [Cl. 23-66.] Carbon dioxide is passed through a slaked lime slurry under controlled conditions until substantially all of the hydroxide has been converted to calcium carbonate.

Strecker, Gerald. Conveyor driving means for sheet cutting and stacking devices. U. S. patent 2,670,955. Filed Aug. 24, 1950. 2 claims. Assigned 50% to Kommandit-Gesellschaft, or limited liability company, Dr. Otto Strecker, and 50% to Maschinenfabrik zum Bruderhaus Gesellschaft mit beschränkter Haftung. [Cl. 271-76.] Web feed and the conveyor units are coordinated to operate at the highest possible speed consistent with sheet weight, size, etc.

Sweeney, Orland R., Arnold, Lionel K., and Long, Justin T. Plastic from furfural and lignin or lignin sulphonic acid. U. S. patent 2,671,061. Filed Jan. 24, 1951. 10 claims. Assigned to Iowa State College Research Foundation, Inc. [Cl. 260-17.5.] Furfural mixed with an aromatic amine and lignosulphonic acid and an acidic condensing agent produces a plastic material useful for making chemically resistant tanks, pumps, etc.

Thompson, Ralph N. Method of dispersing satin white. U. S. patent 2,671,032. Filed March 4, 1950. 4 claims. Assigned to Calgon, Inc. [Cl. 106-306.] Addition of an animal or vegetable protein and an alkali metal phosphate to satin white is claimed to make it readily dispersible and lower the adhesive demands of the coatings using same.

Wenzelberger, Elwood P., and Wohl, Kurt A. Process for making crush resistant boxboard. U. S. patent 2,670,663. Filed May 3, 1951. 3 claims. Assigned to The Weston Paper and Manufacturing Co. [Cl. 92-39.] Starch-urea-formaldehyde resin to improve crush resistance of corrugated board is controlled so that polymerization of the resin is progressive during sheet formation, corrugation, etc.

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Bourgeois, Charles. Sound-absorbing panel. U. S. patent 2,671,522. Filed March 31, 1950. 1 claim. [Cl. 181-33.] Sound-absorbing panels of wood or glass fiber contain two sets of alternately deep and shallow grooves.

Chavannes, Marc, A., and Howden, James W. Method and apparatus for bonding fibers together. U. S. patent 2,671,496. Filed March 23, 1950. 11 claims. Assigned to Chavannes Industrial Synthetics, Inc. [Cl. 154-29.] Cotton, jute, glass, or other fibers are formed into a pad on a moving belt together with powdered thermoplastic resin. Streams of hot air melt the resin and streams of cold air set the resin to firmly bond the fibers in the pad.

D'Ambrosio, Anthony. Method of making compact holders. U. S. patent 2,671,384. Filed Feb. 10, 1951. 3 claims. [Cl. 93-96.] Cloth-covered paperboard case is made in two parts and the parts combined to make a fabric-covered box.

Danziger, Philip F. Shirt packaging form. U. S. patent 2,671,581. Filed Nov. 24, 1951. 5 claims. Assigned to Market Industries Co., Inc. [Cl. 223-71.] Combination shirt board and collar support.

Efurd, Robert L., Jr., and Efurd, Euland A. Adjustable cutter head for bark-removing machines. U. S. patent 2,671,480. Filed June 23, 1948. 5 claims. [Cl. 144-208.] Portable barker has operator-controlled cutter head and feed wheels to protect the equipment against damage from branch stubs and the like.

Fidell, Louis I. Method of blending fibers. U. S. patent 2,671,250. Filed May 21, 1952. 12 claims. Assigned to American Cyanamid Co. [Cl. 19-146.] At least one of the fibers is dyed with a fluorescent dye and blending continued until inspection under ultraviolet light indicates satisfactory results.

Goldstein, Nathan, and Scherr, Henry J. Paper parasol.

U. S. patent 2,671,458. Filed Sept. 3, 1948. 2 claims. [Cl. 135-20.] Toy formed with a paper cover and cardboard stiffening ribs.

Johenning, Franz, and Baums, Otto. Method and mechanism for unfolding, refolding, setting up, and transporting tubular cartons in spaced relationship. U. S. patent 2,671,385. Filed Feb. 13, 1952. 19 claims. Assigned one half to Jagenberg-Werke Akt.-Ges. [Cl. 93-53.] Machine refolds tubular carton blanks to break score lines, then directs the setup carton into a compartment of an adjoining conveyor.

Jungmayr, Theodor. Folding mandrel for making bags. U. S. patent 2,671,383. Filed March 29, 1951. 4 claims. Assigned to Firm Fr. Hesser, Maschinenfabrik-Aktiengesellschaft. [Cl. 93-12.] Group of mandrels mounted around a central shaft are contracted by a control rod after bags are formed.

Kunz, Eric, C., Weston, William H., Jennison, Marshall W., Sweet, Herman R., and Kitchens, Garry C. Process for forming a lignin concentrate. U. S. patent 2,671,751. Filed Dec. 3, 1948. 5 claims. Assigned to The Givaudan Corp. [Cl. 195-2.] Lignin concentrate containing 35% lignin is produced by inoculating wood meal with cellulose-destroying fungi in the presence of nutrients with temperature controlled at 28 to 32°C.

Kurlinski, Bernard J. Rewind core spacer. U. S. patent 2,671,618. Filed March 15, 1952. 2 claims. [Cl. 242-68.] Spacers accurately position the cores on duplex-type rewinder shafts and are easily adjusted for length.

Lander, James G. Method of preventing adhesion. U. S. patent 2,671,747. Filed March 11, 1950. 3 claims. Assigned to Diamond Alkali Co. [Cl. 154-138.] Application of a mixture containing 8% urea, 0.2% triethanolamine, and the balance consisting of sodium silicate containing 37% solids is claimed to prevent adhesion of sodium silicate to platens and rolls of laminating machinery.

Leavitt, James P. H. Shipping container. U. S. patent 2,671,597. Filed June 22, 1949. 3 claims. Assigned to Container Corp. of America. [Cl. 229-14.] Top and bottom sections are fastened to a cap closure and telescope over a full-length liner.

Leavitt, James, P. H. Shipping container. U. S. patent 2,671,600. Filed Oct. 25, 1949. 2 claims. Assigned to Container Corp. of America. [Cl. 229-23.] End sections telescope over a liner to make a large container suitable for textiles and the like.

Leavitt, James P. H. Shipping container. U. S. patent 2,671,601. Filed Oct. 25, 1949. 1 claim. Assigned to Container Corp. of America. [Cl. 229-23.] Tubular body sections telescope over a liner, which with tray-type top and bottom elements, makes a large container easily packed or unpacked.

Miller, Andrew E. Chick box cleat. U. S. patent 2,671,594. Filed Oct. 7, 1948. 1 claim. Assigned to Alton Box Board Co. [Cl. 229-6.] Corrugated board is laminated and cut in a "T" shape with the corrugations heightwise and the unit held in slots in the box top.

Miller, Andrew E. Chick box cleat. U. S. patent 2,671,595. Filed Sept. 28, 1951. 2 claims. Assigned to Alton Box Board Co. [Cl. 229-6.] Very similar to U. S. patent 2,671,594.

Page, John E. Collapsible container. U. S. patent 2,671,592. Filed May 26, 1951. 3 claims. Assigned to Gibson Patent Containers, Ltd. [Cl. 229-5.7.] Circular end closures are attached to a cylindrical paperboard body with a sheet metal rim.

Page, John E. Paperboard container. U. S. patent 2,671,593. Filed Feb. 7, 1952. 5 claims. Assigned to Gibson Patent Containers, Ltd. [Cl. 229-5.7.] Very similar to U. S. patent 2,671,592 (March 9, 1954) above.

Price, Alfred S. Storage battery top protector. U. S. patent 2,671,599. Filed July 25, 1950. 3 claims. [Cl. 229-16.] Double- or triple-ply cover protects fill plugs and terminals and makes stacking of batteries possible.

Rosen, John. Corrugated board box construction. U. S. patent 2,671,598. Filed Aug. 23, 1950. 2 claims. [Cl. 229-15.] Outer carton and liner units are combined to form a double-walled carton.

Rosenblum, Carl. Nonsmudging transfer sheet. U. S. patent 2,671,734. Filed March 25, 1949. 3 claims. Assigned to Rose Ribbon & Carbon Mfg. Co., Inc. [Cl. 117-36.] Antismudge coating comprising beeswax or the like and bronze powder to prevent smudging from carbon papers.

Sahlen, Henry P. Garment hanger. U. S. patent 2,671,582. Filed Nov. 10, 1950. 3 claims. [Cl. 223–98.] Cardboard cover for wire hanger.

Taylor, Harwood S., Jr. Folding box packer and carrier. U. S. patent 2,671,584. Filed March 6, 1950. 1 claim. Assigned to F. M. Howell & Co. [Cl. 224–48.] Packing element upon removal from the container makes a carrier for the enclosed articles.

Taylor, Russell C. Container with flat top and integral overcap. U. S. patent 2,671,596. Filed Nov. 18, 1948. 6 claims. Assigned to American Can Co. [Cl. 229-7.] Paperboard milk carton with a protective cover to keep top of the carton clean.

Vogt, Clarence W. Apparatus for producing enwrapments in series. U. S. patent 2,671,382. Filed Feb. 14, 1949. 8 claims. [Cl. 93-1.] Web fed to this machine is printed, scored, formed into bags and the bags filled and sealed before the web is severed to release the individual units.

Vogt, Clarence W. Chain of bags. U. S. patent 2,671,602. Filed Sept. 4, 1948. 8 claims. [Cl. 229-53.] Thermoplastic adhesive is used to seal the flap of one bag to the bottom of the preceding bag and a tab between the bags so they are advanced through the filling machinery in pairs. The seals are released after filling is completed.

Vogt, Clarence W. Commodity package. U. S. patent 2,671,731. Filed April 12, 1950. 5 claims. [Cl. 99-171.] Units such as quarter-pound bars of butter or margarine are individually wrapped, then sealed together in groups by a band that covers the bottom and ends and is scored for easy separation of the units.

Walsh, Robert A. Improvement in label and label protector. U. S. patent 2,671,678. Filed Feb. 20, 1950. 1 claim. [Cl. 282-27.] Label incorporated with a transparent covering material to protect it from damage after application to the package.

Westcott, Dana B., and Field, Harold L. Manufacture of pulp by the alkaline process. U. S. patent 2,671,727. Filed May 5, 1948. 8 claims. Assigned to West Virginia Pulp & Paper Co. [Cl. 92-9.] Group of digesters connected with an accumulator may be individually cut out of the system to blow and refill, then liquor from the accumulator is introduced at 145–175°C. at a sodium oxide content of 10 to 20 grams per liter. The liquor is constantly refortified as necessary to maintain the desired concentration. More uniform pulp and steam demands are among the advantages claimed for the system.

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Bauling, Adrianus L., and Milne, David T. Process for rendering films and the like water-repellent, greaseproof, and moistureproof. U. S. patent 2,672,427. Filed May 26, 1951. 19 claims. Assigned to American Viscose Corp. [Cl. 117-140.] An aqueous emulsion containing sodium carboxymethyl cellulose, paraffin, and a plasticized melamine-formaldehyde resin is applied and the film heated to cure the resin.

Baxter, Thomas R. Package. U. S. patent 2,672,233. Filed Nov. 30, 1949. 1 claim. Assigned to Continental Can Co., Inc. [Cl. 206-57.] Film wrapper for cellulose tissues incorporates cardboard bottom stiffener.

Crane, Walton B. Container. U. S. patent 2,672,274. Filed July 29, 1949. 2 claims. Assigned to Max Factor & Co. [Cl. 229-37.] Tissue dispensing container with decorative cut-out and hinged cover panel.

Ertner, Edward W. Apparatus for coating webs, including adjustable doctor blade. U. S. patent 2,672,119. Filed Aug. 23, 1951. 7 claims. Assigned to Western Electric Co., Inc. [Cl. 118-118.] Apparatus especially for application of lacquer to webs contains a doctor to remove excess from the edge of the spreader roll.

Fraser, Douglas. Machine for treating paper mill waste. U. S. patent 2,672,072. Filed Feb. 20, 1950. 4 claims. [Cl. 92-20.] Pulps for broke, esparto grass, or straw comprises a vat with projecting brackets mounted on the inside wall and a vertically mounted driven shaft from which drag arms radiate to cooperate with the brackets. Accepted stock and dirt pass through the perforated bottom wall.

Gross, William E., Hale, Frank B., and Brown, Irving C. Trimming and wrapping machine. U. S. patent 2,672,196. Filed April 13, 1936. 15 claims. Assigned to United States of America as represented by the Secretary of War. [Cl. 164-42.] Rotational speed of trimming knives is adjusted to be proportional to web speed to avoid tearing of weak paper such as filter papers.

Halpern, Bernard R. Paper-cutting machine. U. S. patent 2,672,197. Filed Feb. 2, 1950. 17 claims. [Cl. 164-55.] Blade is of light construction and oscillates during the cutting stroke to slice rather than shear through pile of paper.

Harwood, James, Hoerr, Charles W., and Reck, Richard A. Separation of tall oil acids. U. S. patent 2,672,458. Filed Feb. 8, 1952. 11 claims. Assigned to Armour and Co. [Cl. 260-97.6.] Acetonitrile containing closely controlled amounts of water precipitates the resin acids from tall oil while leaving the fatty acids in solution.

Hornbostel, Lloyd. Suction press assembly. U. S. patent 2,672,078. Filed April 5, 1950. 5 claims. Assigned to Beloit Iron Works. [Cl. 92-49.] Pickup felt removes web from the wire and carries it through the first press nip, after which it is transferred to two succeeding felts as it passes through the second and third nips with suction applied on alternate sides of the web before transfer from the third felt to the press roll.

Lyijynen, Fred. Die apparatus for making laminated panels. U. S. patent 2,672,176. Filed May 17, 1949. 6 claims. As-

signed to Briggs Manufacturing Co. [Cl. 154-1.] Forming die for laminated automobile door panels.

Reed, Lou C. Apparatus for manufacturing wallboard joint tape. U. S. patent 2,671,990. Filed May 1, 1950. 9 claims. Assigned to The Marvan Corp. [C.. 51-75.] Pairs of grinding wheels bevel the edges on one side, then the reverse side, as the tape passes through the device.

Rother, Richard J., and McManus, Albert R. Coating composition for paperboard comprising an aqueous dispersion of a butadiene-styrene copolymer and a hydrous aluminum silicate clay. U. S. patent 2,672,454. Filed March 25, 1953. 6 claims. Assigned to Gaylord Container Corp. [Cl. 260-17.4.] Coating material for the interior of containers used for packaging asphaltic materials; said coating being compatible with the packaged material and easily stripped from the paperboard to avoid contamination of the packaged material with board fibers.

Rudine, Clifford. Multiple section container. U. S. patent 2,672,275. Filed Jan. 9, 1950. 4 claims. [Cl. 229-37.] A single blank is folded to produce two completely sealed cartons which may be separated by the user without disturbing the seals.

Schmid, Otto. Cyclone separator for separating solid particles from gases. U. S. patent 2,672,215. Filed Aug. 16, 1951. 4 claims. [Cl. 183-84.] Cyclonic separator incorporates a frusto-conical baffle at the top of the collection hopper to direct solid particles downward and purified air upward toward the outlet.

Smith, Thomas K. Carton. U. S. patent 2,672,273. Filed June 14, 1949. 5 claims. [Cl. 229-37.] Eight-paneled blank is folded to make a double-walled carton with fracture lines incorporated in the outer walls to form a hinged, telescoping cover.

Steinhardt, David W. Eradication of marks from reactant record material. U. S. patent 2,672,396. Filed June 23, 1951. 10 claims. Assigned to The National Cash Register Co. [Cl. 8-102.] Use of propionic, butyric, or hydrochloric acids with methylethyl ketone or ethyl acetate as solvents is claimed. Similar to U. S. patent 2,669,503 (Feb. 16, 1954).

Thorsell, Edward P. Apparatus for manufacturing wallboard joint tape. U. S. patent 2,671,991. Filed Nov. 10, 1951. 4 claims. Assigned to The Marvan Corp. [Cl. 51-75.] Similar to U. S. patent 2,671,990 (March 16, 1954). See abstract above.

Viger, Avenon S. Attachment to machines for forming pulp. U. S. patent 2,672,077. Filed April 18, 1952. 6 claims. Assigned to Lamb-Grays Harbor Com. [Cl. 92-43.] Dewatering roll associated with cylinder mold is pivotally mounted so it is free to move should the drip pan become dislodged and be carried upward by a mass of pulp.

Walters, Theodore M. Centrifugal pulp cleaning and screening apparatus. U. S. patent 2,672,238. Filed May 14, 1952. 6 claims. [Cl. 210-67.] Pulp is received in the interior of this rotating, cylindrical, slotted screen mounted vertically within an outer vat. A vertically reciprocating spray tube with a number of nozzles mounted along its length cleans the outer screen wall. Accepted pulp is removed through a conduit in the bottom wall outside the screen and rejected stock is removed through the bottom wall inside the screen.

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Akers, Victor. Shirt protector. U. S. patent 2,673,015. Filed Sept. 26, 1949. 5 claims. [Cl. 223-71.] Integral shirt board and collar support.

Colgren, Carl T. Package of stacked receptacles. U. S. patent 2,672,981. Filed Sept. 8, 1947. 9 claims. Assigned to Sutherland Paper Co. [Cl. 206-65.] Paper cups are wrapped in a transparent, heat-sealable material with label enclosed underneath the wrapper.

Flint, Eugene, M. Apparatus for treating flexible webs. U. S. patent 2,672,844. Filed June 21, 1951. 4 claims. Assigned to Vapo Systems Co. [Cl. 118-315.] Interconnected air and fluid supply lines and a fluid return line make possible close control of the solids content, temperature, or other variable of material applied to the web.

Harris, George C. Alkaline pulping using gaseous oxygen. U. S. patent 2,673,148. Filed Oct. 4, 1950. 6 claims. Assigned to Hercules Powder Co. [Cl. 92-9.] Gaseous oxygen at 800 p.s.i. 125–175°C., for 2 to 5 hours in the presence of alkaline (pH 7–9) solutions of sodium bicarbonate, sodium benzoate, etc. is claimed to effectively pulp all cellulosic materials with a high yield of lignin-free holocellulose.

Kafka, Mike P. Portable log peeler. U. S. patent 2,672,899. Filed Nov. 28, 1952. 3 claims. Assigned $33^1/_3\%$ to Martin A. Benda and $33^1/_3\%$ to George A. May. [Cl. 144-208.] Motor-driven eccentric connected to reciprocating blade forces the blade between log and bark.

Kuss, Ralph L. Flat bottomed tubular container. U. S. patent 2,673,024. Filed June 11, 1951. 1 claim. [Cl. 229-57.] Design for liner to be used within square or hexagonal container and in which extra material is provided at the corners to prevent damage to the liner during filling.

McPartland, Edward T. Disposable umbrella for emergency use. U. S. patent 2,672,877. Filed Feb. 3, 1950. 2 claims. [Cl. 135-19.5.] Waterproof paper, cardboard, or plastic is folded to make a collapsible umbrella.

Morelock, Oliver J. Moisture testing apparatus. U. S. patent 2,673,327. Filed March 15, 1952. 2 claims. Assigned to Western Electrical Instrument Corp. [Cl. 324-65.] Circuit is claimed for moisture meter which measures the resistance of materials passed between driven rolls.

Nordquist, Ronald E. J. Fiber container with duplex closure member. U. S. patent 2,673,021. Filed April 28, 1949. 5 claims. Assigned to American Can Co. [Cl. 229-7.] Friction plug closing element and overcap to protect the top of a paperboard milk carton.

Peterson, Howard B., and De Gear, Edward. Container closing machine with centering device. U. S. patent 2,672,791. Filed March 28, 1952. 7 claims. Assigned to American Can Co. [Cl. 93-39.2]. Machine for applying the end closure to fiberboard bodied containers of the type used for packaging frozen foods.

Prossen, Louis F. Carton. U. S. patent 2,673,022. Filed Jan. 4, 1950. 3 claims. Assigned to Celanese Corp. of America. [Cl. 229-15.] Carton with palletized base and partitions fastened to the midpoint of each sidewall.

Risch, Arthur H. Molded pulp pallet support. U. S. patent 2,673,052. Filed Dec. 14, 1950. 6 claims. Assigned to Pulp Reproduction Co. [Cl. 248-120.]

Ross, Colin A. Dispensing carton. U. S. patent 2,672,979. Filed March 21, 1950. 1 claim. Assigned to Behr-Manning Corp. [Cl. 206-60.] Outer carton and drawer combination from which the contents may be removed or replaced easily.

Russell, Alexander, Hopton, Alan, and Carter, Arthur, F. Wrapping machine. U. S. patent 2,672,717. Filed April 3, 1951. 25 claims. Assigned to The Forgrove Machinery Co., Ltd. [Cl. 53-41.] Stacks of biscuits or like items are wrapped in heat-sealable material or paper.

Tardiff, Ray O. Combination package. U. S. reissue patent 23,806. Filed Dec. 29, 1953. 2 claims. Assigned to Breyer Ice Cream Co. [Cl. 229-15.] Tray member to hold cup cakes or the like within a conventional carton.

Vander Lugt, Thomas, Jr. Collapsible partitioned display carton. U. S. patent 2,673,023. Filed June 29, 1953. 8 claims. Assigned to Sutherland Paper Co. [Cl. 229-41.] Paperboard blank is folded to provide a three-celled container which is overwrapped with transparent material to complete the package.

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Amberg, Walter E., and Amberg, Stephen W. Method of forming truncated conical paper cups. U. S. patent 2,673,496. Filed Feb. 9, 1950. 8 claims. Assigned to Lily-Tulip Cup Corp. [Cl. 93-36.] Apexial end of a conical paper cup is compressed to a rounded bottom suitable for fountain or similar use.

Bainbridge, John P., Jr. Preventing offset of print from freshly printed papers. U. S. patent 2,673,520. Filed Feb. 9, 1948. 5 claims. Assigned to Monsanto Chemical Co. [Cl. 101-416.] A spray or mist containing silica particles less than one micron in diameter is claimed to prevent offset in stacking or rewinding freshly printed paper.

Deutschmeister, Herman, and Deutschmeister, Abraham. Two-way mailing device. U. S. patent 2,673,680. Filed April 4, 1950. 3 claims. [Cl. 229-73.] Preformed envelope and return envelope.

Dunn, John R. Shower for pulp washers. U. S. patent 2,673,763. Filed Jan. 26, 1953. 3 claims. Assigned to Canadian International Paper Co. [Cl. 299-121.] Internal baffle in the shower pipe contains holes to provide uniform flow of water to the slotted portion of the pipe from which it flows onto the deflector plate.

Evers, Arthur J. Striker mechanism for bagmaking machines. U. S. patent 2,673,610. Filed April 3, 1952. 5 claims. Assigned to International Paper Co. [Cl. 164-36.] Constantly rotating striker mechanism cuts tubing into bag lengths when pinch rolls interrupt advance of the web.

Fleischer, Leo S., and Tackenberg, Richard C. Wrapping and packaging machine. U. S. patent 2,673,430. Filed June 18, 1949. 2 claims. Assigned to The Crystal Tissue Co. [Cl. 53-84.] Flat articles are sealed between upper and lower webs of cellophane or waxed paper, then the individual packages severed from the web and the cut edge sealed to the top of the package.

Gilcrease, John R. Dusting of rubberlike materials with cellulose. U. S. patent 2,673,844. Filed Dec. 22, 1950. 7 claims. Assigned to Standard Oil Development Co. [Cl. 260-17.4.] Powdered, lignin-free, fibrous wood cellulose dusted on the surface of butadiene-nitrile and like materials is claimed to prevent coalescence of said materials when stored as crumbs.

Goss, Worth C. Method of manufacturing sheet lumber.

U. S. patent 2,673,370. Filed Aug. 17, 1951. 13 claims. Assigned to The Sheetwood Products Co. [Cl. 18-47.5.] Lignocellulosic material with hydroplastic bonding agent is formed in a pad with high moisture content materials on the surface and low moisture content materials in the body to produce a board with a dense surface and, at the same time, substantially reduce dwell time in the press.

Greenawalt, John E. Method and apparatus for recovering chemical products from waste materials. U. S. patent 2,673,787. Filed Jan. 18, 1946. 21 claims. [Cl. 23-48.] Recovery furnace for waste liquors is lined with coiled pipe through iwhich liquid coolant is circulated to control temperature withn the furnace. Wheel-type burner is suspended through the roof and throws a atomized fuel into the combustion zone. Molten noncombustible slag forms a crust of controlled thickness on the pipes and flows out through a draw-off spout into the dissolving tank.

Harker, Charles B. Packaging machine. U. S. patent 2,673,431. Filed April 30, 1953. 11 claims. Assigned to Harold L. Bartelt and Donald E. Bartelt. [Cl. 53-89.] Pouches are formed in a heat-sealable web and the bags severed from the web as they advance toward the filling station. A splitter bar ensures opening of the bag for filling.

Haw, John O. Packaging apparatus. U. S. patent 2,673,432. Filed Nov. 8, 1952. 3 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 53-105.] Device for wrapping cakes of rayon yarn with a tube of porous paper fed from a supply roll.

Hecker, Leonard R., and Clark, Murray P. Method and apparatus for making bags. U. S. patent 2,673,495. Filed March 13, 1946. 5 claims. Assigned to Continental Can Co. [Cl. 93-35.] Machine forms a continuous web into garment bags of the type used by dry cleaning establishments.

Heitmann, Hans. Machine for the manufacture of envelopes and flat bags with inside arranged folding seams. U. S. patent 2,673,497. Filed May 4, 1950. 9 claims. [Cl. 93-63.] Work holders on the conveyor carry the formed bag through the drying chamber of this compact machine to reduce the size of the drying unit.

La Bombard, Leon E. Collapsible box. U. S. patent 2,673,679. Filed Aug. 27, 1948. 5 claims. [Cl. 229-38.]

Morton, Woolridge B. Packing case. U. S. patent 2,673,678. Filed Aug. 17, 1949. 3 claims. Assigned to Wilbro Corp. [Cl. 229-37.] Scored edges of a conventional fiberboard l corrugated board packing cases are impregnated with resin and set between dies to improve the stacking resistance of the case.

Richman, Nurney H. Shirt package and blank for forming same. U. S. patent 2,673,667. Filed Feb. 9, 1953. 9 claims. Assigned to Scientific Packages, Inc. [Cl. 223-71.] Shirtboard and collar protector combination.

Riebe, Edward J. Apparatus for forming and wrapping products. U. S. patent 2,673,429. Filed July 26, 1950. 3 claims. [Cl. 53-56.] Machine for cutting pats of butter from a quarter-pound bar and individually wrapping same.

Ringler, William A. Fully partitioned carrier with reinforced handle. U. S. patent 2,673,677. Filed April 7, 1950. 4 claims. Assigned to The Gardner Board and Carton Co. [Cl. 229-28.] Bottle carrier.

Schur, Milton O., and Levy, Robert M. Cigarette paper. U. S. patent 2,673,565. Filed Nov. 9, 1951. 2 claims. Assigned to Ecusta Paper Corp. [Cl. 131-15.] Addition of magnesium carbonate to cigarette paper is claimed to improve the ashing properties of same while at the same time eliminating the use of phosphoric acid with its attendant difficulties.

Schur, Milton O., and Levy, Robert M. Method of producing cigarette paper. U. S. patent 2,673,799. Filed Sept. 25, 1952. 2 claims. Assigned to Ecusta Paper Corp. [Cl. 92-21.] Very similar to U. S. patent 2,673,565 (March 30, 1954). See abstract above.

Scott, Harold E. B. Doctor for paper and like machines. U. S. patent 2,673,494. Filed Nov. 29, 1951. 8 claims. [Cl. 92-74.] Machined rod or sheet metal insert in the blade holder makes for easy removal of the blade and interchange of different blades by changing only the insert.

Segl, Walter E. Method for the digestion of cellulose-bearing material. U. S. patent 2,673,690. Filed Oct. 27, 1951. 9 claims. Assigned to Hercules Powder Co. [Cl. 241-3.] Raw materials are fed into the digestion chamber and digested material removed from the chamber by a screw that compacts the material into a plug which is opposed by a ram. Pressure of the ram disintegrates the plug and a new plug is formed. These plugs act as seals to prevent loss of pressure in the digestion chamber. A series of shells within which screw conveyors move the material during digestion comprise the digestion chamber.

Tsunoda, Yoshio. Process for making cupra-ammonium rayon spinning solution. U. S. patent 2,673,811. Filed Sept. 29, 1950. 2 claims. Assigned to Asahi Kasei Kogyo Kabushiki-Kaisha. [Cl. 106-167.] Supersonic vibrations at 15 kc. is claimed to aid in dissolving cotton linters in cuprammonium solution and produce rayon with improved characteristics.

Wagner, Kenneth A. Sheet counter for paper sheet handling machines. U. S. patent 2,673,498. Filed April 8, 1952. 2 claims. [Cl. 93-93.] Toothed wheel engages folded sheets as they are advanced on the conveyor and marks predetermined numbered sheets with a marking pencil as they pass the wheel.

Zündel, Jean E., and Aries, Robert S. Deinking. U. S. patent 2,673,798. Filed July 20, 1949. 3 claims. [Cl. 92-1.5.] A caustic soda extract of coniferous bark together with a detergent such as trisodium phosphate and caustic soda is claimed to be very effective in deinking of newsprint. Bark consumption (steamed bark is preferred) amounts to about 6.2% and caustic soda consumption to about 3.25% based on weight of newsprint.

LETTERS TO THE EDITOR

Paper, Printing, and Eyestrain

To the Editor, *Tappi:*

I was told that very careful work has been done in the United States to determine the characteristics that a printed paper must show to be read with the least possible fatigue. These characteristics are concerned with color and gloss of the paper, color, shape, and size of the printing type.

Could you tell me if any papers have been published on this matter, where and when (bibliographic references).

Henri F. Brun, *Technical Manager*
Soc. des Produits du Mais
Paris, France

To the Editor, *Tappi:*

This will acknowledge receipt of your letter requesting literature reference relative to the characteristics of a printed paper which will result in less eyestrain.

We have not, in our laboratory, had the occasion or the time for investigations along this line. The problem lies somewhat outside the field of production printing and involves a fundamental study with a wide horizon. For example, a careful examination should first be made of the fields included by visibility, legibility, and readability, and when defined it will be seen that these functions involve not only light reflectance, which is scientifically measurable by critical standards, but also ocular reactions to these measured properties which may vary widely with individuals or races of peoples.

Thus, there appear to be ocular and psychological factors combined with habits or training which complicate the problem for solution by simple standards.

It would seem that the subject is too important to be treated superficially and should require a long time study from several angles before any very positive conclusions might be drawn. Correct conclusions could only be drawn from the collaborative studies of the physicists (light engineers), oculists, physiologists, psychologists, typographers, type designers, printers and manufacturers of their products—inks, papers, etc.

There is a consensus of agreement among commentators on the effect of colors on vision, namely, that the portion of the spectrum from the yellow-green to the violet end is less irritant to the eye and the nervous system than the portion from the center to the red end of the spectrum.

There appears to be some difference of opinion as to the most desirable color of paper from the point of view of reducing eyestrain over long periods of time in reading. Buff or light cream color and very light tints of green appear to lead in popularity.

Mathew Luckiesh, Director of Lighting Research Laboratories, and his colleague, Frank K. Moss of the General Electric Co. at Schenectady, N. Y., have done some research along the line of illumination and reflection of light published in part as follows:

"Visibility: Its measurement and significance in seeing," *Journal of the Franklin Institute* 220, No. 4: October, 1935.

"The relative visibility of print in terms of illumination intensity," *The Sight-Saving Review* 5, No. 4: December, 1935.

"Foot candle prescriptions," *The Magazine of Light*, March, 1936.

"Visual tasks in light saving classes," *The American Journal of Ophthalmology* 19, No. 11: November, 1936.

You might get a bibliography from Mathew Luckiesh, Director of Lighting Research Laboratories, General Electric Co., Schenectady, N. Y.

There was an article discussing some of the phases of the subject entitled "Legibility," on page 43 of the February, 1937, issue of the *Inland Printer*.

Also, some research was done by the Fitchburg Paper Co. in working up a new buff-tinted paper. This paper, which they have called "Facilex," when printed on with nonglossy ink, gives a very effective result which seems to facilitate reading. Information concerning this development can be obtained from John W. O'Connor, Fitchburg Paper Co., Fitchburg, Mass.

Some observations on the effect upon vision of colors and light reflection have also been made by the National Bureau of Standards in their letter circulars from time to time under such headings as "Color and Legibility" and "Memorandum on Ledgers and Legibility," etc. These data may, no doubt, be obtained from Robert Hobbs, Chief of Paper Section, National Bureau of Standards, Washington, D. C.

Quoting from a Bureau of Standards "Memorandum on Ledgers and Legibility": "The Color of the Paper: The all-important factor is that the paper color gives a high brightness control with the color of the writing ink. Since writing inks are usually of dark color, the paper must be of light color; the lighter, the better; but small differences in reflectance are probably of not practical significance. The chromaticity of the paper probably has little effect on legibility; it may be light blue, light yellow, light green, pink, or white; pale colors are probably better than strong colors of the same brightness. It is likely that there is little justification for changing from the conventional white. On the other hand, there is no need for controlling the chromaticity accurately as far as legibility is concerned. For example, the blue dye usually added to counteract the yellowness of the stock decreases legibility somewhat by darkening the paper."

The following quotation is from an article by H. C. Kulling, the originator of a new type form for the 1938 Ann Arbor Telephone Directory, "Legibility first," published in *Paper and Printing Digest*, January, 1939, page 6, William Bond Wheelwright, publisher, 909 Foster Ave., Chicago, Ill.

"The color of ink and the background also have been given much consideration, and here again the aesthetic comfort or satisfaction of the reader is something that seems to be confused with or interpreted into eye comfort. However, our analyses of the statements of those who have made extensive tests indicate that the maximum of contrast, which is black on white, is best for reading where reading is done for relatively short periods. Where reading is done for any extended period, one test showed a slightly cream tinted paper is desirable."

Quoting from the chapter on legibility, page 191, "Typographical Printing Surfaces," by Lucien A. Legros and John C. Grant, Longmans, Green & Co., 4th Ave., New York, N. Y.

"The best effect is secured by having the greatest contrast and for this reason the ink should be perfectly black and dead in color, and the paper as white as possible. Yellow and gray tend to diminish the contrast and are unfavorable, while pink and red are actually harmful to the sight. In the search for a distinctive color which should be the least harmful to the eye, the late Sir George Newnes consulted many of the highest authorities, and finally adopted the light green shade of paper on which the *Westminster Gazette* has for many years been printed. In cases where much writing has to be carried out on forms printed on colored paper, it is advisable that the tints selected should be light and should be chosen from the green to the violet end of the spectrum."

An interesting effect of tinted paper on the formation of optical after-images during reading is recorded by Ward A. Holden, in his article on "The fluttering produced by the juxtaposition of certain colors and of black and white," in the "Archives of Ophthalmology," Vol. XXVII, No. 1. The presence of these after-images affects the legibility of the printed page.

"Reading a single line of type will not produce a perceptible after-image of the line, but when a number of successive lines are read, the fatiguing effect on the retina is cumulative and produces white after-images of the lines. If ten lines of the page are read and the gaze is then directed to the blank margin of the page, one will see a number of white after-images, each as broad as a line of print, and then will persist for five or ten seconds. The confusion in reading, due to these after-images, is more marked when the paper is glazed and glaring blue-white than when it is cream tinted."

There is a résumé of observations on the effects of paper and ink on legibility in a publication (1926) by the Medical Research Council of Great Britain in a 123-page report on "The Legibility of Print" by R. L. Pyke, working in the psychological laboratory of Cambridge University. Some of the observations date back to 1827. Some assert a yellow or cream tint of paper stock is preferable, but the majority hold that the maximum degree of contrast between white and black involves less eyestrain and greater legibility.

Considerable data have been presented on the legibility of color the Color Research Laboratory of the Eagle Printing Ink Co., Division of General Printing Ink Corp., New York, N. Y.

In a 17-page report (1922) prepared by Lucien A. Legros of London, for the information of the Committee on Type Faces, the following statement occurs concerning "The Color of Paper."

"The color of paper is of great importance in obtaining the necessary contrast between ink and paper. Generally, the other requirements are that the paper shall not be so rough as to obtain a ragged impression of the type and it should not be so smooth as to reflect a definite beam of light. For ordinary printing in black ink, the paper should be white or only very slightly colored; for covers and advertisements, the light green shade selected for the *Westminster Gazette* by the late George Newnes, after much consultation, is generally found most restful for the eyes; the same color is used commonly for green rooms of theaters and for the Post Office sorting vans on trains. Where colored paper is used for covers and for distinguishing classes of papers or forms, blue, green, or yellow should be used, while violet, orange, red, and brown should be avoided altogether or only used in very light shades."

A simple reaction test on legibility of twelve standard type faces was made by Prof. Charles E. Bellaty, Head of the Department of Advertising, School of Business Administration, Boston University, on the students of the University. This test was outlined on page 12 and following of the magazine *Direct Advertising*, Vol. XXV, No. 1.

We have heard that the Bell Telephone Co. has conducted some investigation and, to conserve the sight of employees, has selected a light shade of green for certain office forms.

You might write to David M. Glixon, *Bookbinding and Book Production Magazine*, 50 Union Square, New York, N. Y., for references to articles on this subject which have been published from time to time in that magazine.

Trusting the above information will assist you in compiling literature on the subject.

M. S. Kantrowitz, *Technical Director*
U. S. Government Printing Office
Washington, D. C.

Spirit Process Duplicating

To the Editor, *Tappi:*

This Division is experiencing difficulty in reproducing copy on both sides of the paper in connection with spirit liquid process duplicating work. The specification being adhered to is UU-P-231 dated March 13, 1943, Section IV Part 5, Type I and II.

The trade has indicated to this office that the system is not recommended for both side run, however, they further maintain that a two side run can be made resulting in some show through.

Will you kindly advise if there is any special type copy paper that could be recommended for use to minimize the show through of print. This Division would appreciate any information you may have to submit regarding this situation, and wishes to thank you in advance for your cooperation.

John A. MacCormack, *Commissioner*
N. Y. Division of Standards and Purchase
Albany, N. Y.

To the Editor, *Tappi:*

Reference is made to your letter relative to the spirit duplicating process.

Unsatisfactory copies in two-sided liquid duplicating work can be due to several causes. The primary factor causing show-through or strike-through is due to too much fluid being used in the operation.

Too much fluid may result from the copy paper being too absorbent and picking up more fluid than is necessary or the machine mechanism may deliver too much fluid to the copy paper. In the wick-type machine fuzz may build up on the edge of the felt wick giving uneven distribution or delivering too much fluid.

Low opacity in the copy paper may account for the increase in show-through. An opacity of 93% in the copy paper should be sufficient to reduce the show-through to a minimum. A low opacity also accentuates the appearance of any strike-through which may occur. This will spoil two-sided work. Paper which meets the Federal Specification UU-P-231 should give satisfactory results.

We have determined that our G.P.O. standard duplicator copy paper, used for the liquid process gives satisfactory results.

We have contacted the Printing Division at the Pentagon office, where a great many of the liquid duplicating machines are used and find that they do not have any trouble with producing two-sided work of a satisfactory nature.

We note that the UU-P-231 does not state that two-sided work must be satisfactory but that results must be satisfactory on each side of the paper.

We know of no special type copy paper which would perform more satisfactorily than the copy paper specified in UU-P-231.

M. S. Kantrowitz, *Technical Director*
U. S. Government Printing Office
Washington, D. C.

Stitching Wire for Corrugated Boxes

To the Editor, *Tappi:*

I am endeavoring to build up standards for the performance of flat stitching wire for corrugated boxes, but am not aware of any standard tests which would indicate the required strength characteristics—i.e., probably bending strength.

I should be glad if you advise me whether any tests of this type are made by American boxmakers and perhaps the specifications to which flat stitching wire is purchased.

P. Podolier, *Engineer*
Bowaters Fibre Containers, Ltd.
London, England

To the Editor, *Tappi:*

We have the following information available on stitching wire: (1) copper or galvanized may be used; (2) low carbon steel is used and is made by open hearth or electric process; (3) tensile strength, min., 75,000 p.s.i.; (4) tolerance 0.004 in width, 0.0005 in caliper.

Our main test is runability on our machines. If the wire runs well and is of caliper and width ordered we mark them as acceptable.

E. A. Taub, *Vice-President*
Gibraltar Corrugated Paper Co., Inc.
North Bergen, N. J.

RECENT BOOKS

The Sulphur Data Book. Edited by William N. Tuller. McGraw-Hill Book Co., New York, 1954. Cloth, 6 × 9, 141 pages. $5.00.

This book is a compilation of data of interest to the engineer or chemist using sulphur. It is a compilation prepared by the technical staff of the Freeport Sulphur Co. The five major sections cover: the nature of sulphur; physical and chemical properties; reaction thermodynamics; solubility; and analysis of sulphur. An excellent reference book.

Note: Books reviewed in this column may be obtained from the Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

EMPLOYMENT SERVICE

Positions Wanted

E276-54. Pulp Mill Executive. Science graduate, over 20 years' extensive technical and operating experience in sulphite pulping and bleaching for paper and dissolving grades; also research, cost, and quality control, some sulphate. Desire change to executive position with progressive concern.

E277-54. Chemical or Equipment Sales Executive, technical education. Thorough pulp and paper manufacturing experience. Over 5 years of sales promotion in U. S. and Canadian mills. Familiar with the performance and application of most chemicals and equipment in the paper industry. Seeking job with broader future. Salary required over $12,000 per year.

E278-54. Engineer—Mechanical-Industrial, 32, executive background. Experienced in plant engineering and layout, materials handling, cost reduction, quality control, standards, manufacturing methods, equipment design, and technical writing. B.S.M.E., B.A. Chemistry. Relocate anywhere.

E279-54. Young man, trained in chemistry and chemical engineering, experienced in production, quality control, and development desires a new position, preferably in the East.

E280-54. Technical graduate, 32, 7 years' broad experience in research, development, technical control, and some fourdrinier operating. Particularly qualified on technical control for kraft mill pulping and fine, wrapping, and specialty fourdrinier manufacture. Can take complete charge of technical department and have several years' experience at same. Seeks responsible operating or technical job as technical director or superintendent of a small mill or assistant in larger one.

E281-54. Technical Director or Pulp Mill Superintendent—Paper graduate, developer of major kraft pulp mill processes, specialty papers, converting, literature, stream and air pollution problems.

Positions Open

P383-54. Salesman with chemical training and experience in paper manufacture and pigmented coatings—to sell adhesives. This is an excellent opportunity with a progressive company. Location Middle West.

P385-54. Major board producer requires a technically trained man experienced (over two years) in either paper or board machine coating for addition to technical staff. New England base location but job will require traveling. Salary liberal but dependent on experience.

P388-54. Design Engineer. General Information: The Bowaters Southern Paper Corp. has established its principle office on the site where the company's paper mill is being completed. This location is on U. S. Highway 11, 43 miles northeast of Chattanooga at the junction of the Hiwassee River and U. S. Highway 11. This site, in the vicinity of Charleston-Calhoun, is approximately 13 miles northeast of Cleveland and 15 miles southwest of Athens. The mill together with its facilities for procurement of pulpwood, will represent a capital investment in excess of $50,000,000.00. The company will manufacture newsprint and sulphate pulp. It is a wholly owned subsidiary of the Bowater Paper Corp., Ltd., London, England. The parent company, established in 1882, now operates more than 38 subsidiary companies for the manufacture and sale of paper and paper products. Included in the subsidiary companies is Bowater's Newfoundland Pulp and Paper Mills Ltd., at Corner Brook, Newfoundland, which is one of the largest integrated newsprint mills in Canada. Duties: Drafting, design, layouts, reports, cost estimating, and general engineering field work as required in the pulp and paper industry. Education and Experience: Degree from recognized college in Mechanical or Civil Engineering. Minimum of five years' experience. Personal Qualifications: Age to 36. Candidates should have a good facility for working with people and for working under only general supervision. Salary: Beginning salary will be determined upon individual's qualifications. Procedure for periodic merit review of salaries has been established. Liberal benefit program established including insurances, vacations, retirement plan, etc. Procedure for Handling Applications: (1) Prepare as thoroughly and completely as possible the Bowaters Southern Paper Corp.'s Application for Employment. This form may be obtained directly from the company. (2) The snapshot requested is optional. (3) If necessary, a detailed summary of education and work experience may be attached to the completed application form. (4) The Application and the supplementary material should be mailed to: Industrial Relations Dept., Bowaters Southern Paper Corp., Calhoun, Tenn. (*Note:* It is requested that applicants not make a trip to the company's office unless a specific appointment has been made in advance. All applications will be acknowledged and treated as confidential.)

P389-54. Paper Mill Superintendent for new extra wide cylinder board machine located in the South. Furnish to consist of bleached kraft and bleached hardwood pulps. Experienced in the manufacture of food board specialties and capable of understanding and developing many innovations incorporated in the new paper machine. Submit age, education, experience, present position, and past positions.

P390-54. Paper Chemist. Opportunity for aggressive young man, after an intensive training program, to develop and field test chemicals for use in the pulp and paper industry. Knowledge of paper industry through schooling or experience required. Location New York Metropolitan area.

P392-54. Chemical Engineer or Chemist. Man with good background in pulping, refining, formation, and drying wanted to head expanding research and product development work on fiber preparation and utilization processes for established insulating board mill in South. Must be a good leader for this excellent opportunity.

P393-54. Coating Superintendent. Progressive company has excellent opportunity for a man with a good technical background and expr. in conversion or machine coating or both. Our employees know of this opportunity. Reply giving personal, education and work history together with salary expected.

HELP WANTED

Chemical Engineer with 3 to 5 years' paper industry experience in mill control or mill production. Prime interest must be in the technical aspects of process development work, not in production or sales. Must have the ability to work effectively and smoothly with production personnel. Fully equipped modern Research Center located in Northern New Jersey in metropolitan New York area. Reply, stating educational background and experience. Salary commensurate with education and experience. Reply to Tappi P391-54, % Technical Association of the Pulp and Paper Industry, 155 E. 44th St., New York 17, N. Y.

P394-54. Project Supervisor. We are seeking a man with a papermaking background received either through training or experience who has not only imagination but a certain amount of inquisitiveness and who might be interested in rather an unusual position. Will you write us in detail?

Note: Responses to all advertisements should, unless otherwise indicated, be sent to TAPPI, 155 E. 44th St., New York 17, N. Y.

WANTED: PHYSICAL-ORGANIC CHEMIST

Immediate opening in research and development department of specialty paper manufacturer. Excellent opportunity for young man with initiative, imagination, and good educational background. Experience in paper technology, fibres, and resins, or textile related industry desirable. In first letter give complete résumé of experience, age, education, and present salary.

Address Personnel Director,

Hollingsworth & Vose Company
East Walpole, Massachusetts.

EXCEPTIONAL OPPORTUNITY

in New Modern Paper Mill recently opened at Hadera, Israel

For

Tour Bosses • Machine Tenders • Back Tenders

Excellent salary and living conditions on a contract basis for qualified personnel.

Contact:

AMERICAN ISRAELI PAPER MILLS, LIMITED,

c/o Hudson Pulp & Paper Corp., 477 Madison Avenue, New York 22, N. Y.

All inquiries confidential.

THE UTILIZATION OF SULPHITE WASTE LIQUOR

A Bibliography of the Literature Published During 1953

H. BORDEN MARSHALL and JANNETTE M. NEATE

AMMONIA-BASE PROCESS

KALININA, T. I., *Bumazh. Prom.* 27, No. 12: 5–7 (1952); *C.A.* 47: 2984 (1953).

Fir chips were cooked in a laboratory autoclave with calcium-base and ammonia-base bisulphite liquor containing 5% total and 4% free SO_2. The total cooking time in hours, per cent yield based on moisture-free wood, per cent lignin in pulp, per cent sulphur in lignin, and per cent sulphur dioxide in liquor at the end of the cook for a maximum temperature of 110° were 3.5, 83.9, 29.7, 2.86, and 3.74 for ammonia base, and 3.5, 87.1, 29.7, 2.80, and 3.84 for calcium base, and the corresponding values for a maximum temperature of 130° were 5.5, 72.9, 24.8, 4.20, and 3.42 for ammonia base and 5.5, 75.8, 26.1, 4.25, and 3.45 for calcium base. For a cooking schedule of 1.5 hr. to 110°, 2 hr. stand-in at 110°, 3.5 hr. from 110 to 145°, and variable time at 145°, the values for per cent yield based on moisture-free wood, per cent lignin in pulp, per cent sulphur dioxide in liquor at the end of the cook and per cent screenings for the total cooking time in hours of 7.0 were 55.0, 4.40, 2.72, and 6.5 for ammonia base, and 60.6, 15.10, 2.91, and — for calcium base, and the corresponding values for the total cooking time in hours of 8.5 were 48.7, 0.83, 2.11, and 0.4 for ammonia base, and 50.2, 2.02, 2.37, and 5.7 for calcium base. With the above temperature schedule, pulps were cooked to 75° Björkman; the total cooking time in hours, per cent yield based on moisture-free wood, per cent lignin in pulp, per cent screenings, per cent alpha-cellulose in pulp, and pulp viscosity in millipoises were 8.0, 51.0, 2.10, 1.6, 86.1, and 780 for ammonia base, and 8.5, 50.2, 2.02, 5.7, 86.5, and 688 for calcium base; corresponding values for pulps cooked to 30° were 8.5, 47.3, 0.94, 0.6, 88.9, and 738 for ammonia base and 9.25, 45.3, 1.14, 6.8, 89.95, and 180 for calcium base. In general, when ammonia base is compared with calcium base, the degree of lignin sulphonation is the same, the lignin is removed more rapidly, cooking time is shortened, the pulp is more uniform and the yield is higher, and the viscosity and alpha-cellulose content of the pulp (based on the wood) are higher.

HORTON, J. L., *Pulp & Paper Mag. Can.* 54, No. 3: 205–209, 214 (1953); *C.A.* 47: 9613 (1953).

An outline of the conversion of a sulphite acid plant from a calcium-base into an ammonia-base system (*C.A.* 45: 8764 (1951); 46: 734 (1952)). In the absorption tower, 13 ft. of 4-in. partition tile and 30½ ft. of pulpwood, 5 in. in diameter and 10 in. long, were used. One half of the raw acid entered storage tanks and the other half was recycled. Burner operation proved steadier and temperatures were more stable throughout the system under automatic control than with calcium-base operations.

WHITNEY, R. P., and HAN, S. T., *Tappi* 35: 569–576 (1952); *C.A.* 47: 10847 (1953).

A discussion of the variables involved in the design of ammonium-base sulphite acid absorption towers; the discussion is illustrated with a hypothetical design problem.

JENNESS, L. C., DURST, R. E., and THODE, E. F., *Tappi* 36: 337–342 (1953); *C.A.* 47: 11727 (1953).

Heat-transfer coefficients to ammonia-base sulphite waste liquor in an experimental, vertical, long-tube, forced-circulation evaporator under various conditions were determined with concentrations ranging from 15 to 40%. The over-all heat transfer coefficients varied from 150 to 300 B.t.u. per hr. per sq. ft. per °F. as the solid content changed and as the linear velocity of ammonia-base sulphite waste liquor in the tubes varied from 1 to 5 ft. per sec. When ammonia-base sulphite waste liquor is mixed with kraft black liquor in ratios of 1:1, 2:1, and 4:1 and the mixture is then evaporated, from 67 to 100% ammonia can be recovered. No objectionable precipitation of solids or fouling of the tubes was observed, but serious pit corrosion of the stainless steel vapor space appeared when ammonia-base sulphite waste liquor was evaporated alone.

LINDBERG, E. A. S., Swed. pat. 140,274 (May 5, 1953); *C.A.* 47: 11736 (1953).

Ammonia is recovered from ammonium bisulphite waste liquors by treating them with alkaline black liquor from the sulphate cellulose process after the liquor is freed from volatile organic sulphur impurities by air oxidation.

MARTIN, J. B., *Tappi* 36, No. 6: 175A–176A (1953); *C.A.* 47: 12806 (1953); cf. *Tappi* 23: 830.

By evaporation of ammonia-base sulphite waste liquor four products are manufactured: Orzan A, a slightly acid powder with 6% H_2O content; Orzan AL-45, a slightly acid concentrate with 45% solids content; Orzan S, a slightly alkaline sodium ligninsulphonate with 6% H_2O; and Orzan SL-45, a slightly alkaline sodium-base concentrate with 45% solids.

STOCKMAN, L., *Svensk Papperstidn.* 56, No. 1: 11–14 (1953); *B.I.P.C.* 23: 509 (1953).

Although the price of ammonia in Sweden is about twice that of the United States, so that the application of the ammonia-base sulphite process to Swedish mills does not seem economically feasible at present, these conditions may change in the future. Based on a study trip to the United States, the author describes the experiences gained by some mills which switched from calcium-base to ammonia-base sulphite pulping. The advantages and disadvantages of the process are outlined, and differences in the various stages from acid making to recovery are discussed, with particular reference to the reduction of stream pollution.

BOOTH, K. G., *Pulp & Paper* 26, No. 9: 80–82–84 (1952); *cf. B.I.P.C.* 21: 806; *B.I.P.C.* 23: 754 (1953).

This is a summary of the experience obtained in the operation of the Lebanon, Ore. mill after its conversion from a calcium-base to an ammonia-base sulphite process. A description of the pilot plant for the recovery of heat and sulphur from the waste liquor and its operation during several months is included; this provided the necessary data for designing a full-

H. BORDEN MARSHALL and JANNETTE M. NEATE, Ontario Research Foundation, Toronto, Ont.

scale plant which is now under construction at the Lebanon mill.

Martin, J. B., *Tappi* 36, No. 6: 175–176A (1953); Proc. Fourth Ann. Ind. Waste Conf. State Coll. of Washington: 50–52, discussion, 52 (1952). *B.I.P.C.* 23: 830 (1953).

Orzan is the trade name of ammonia-base sulphite waste liquor made available as a solution or in powdered form by the Industrial Products Division of the Crown Zellerbach Corp. The commercial utilization of Orzan (50 to 60% ammonium ligninsulphonates, 25 to 30% sugars, and 3.5% nitrogen) includes, in addition to the common uses of sulphite waste liquor, a number of applications which are in part or entirely dependent upon the presence of the ammonium ions. The principal among these is its use in agriculture for soil improvement. When used as a dispersant or tanning agent the absence of calcium ions is a decided advantage. Under the influence of elevated temperatures, the ammonia, lignin-sulphonates, and sugars condense to large molecular structures with increasing insolubility of the ingredients in water, although they will swell and soften. Heat-treated Orzan powders may find use in plugging porous strata during oil-well drilling, as conditioners for mixed fertilizers to prevent caking, or as a direct additive to certain soils to loosen them and inprove water retention, etc.

LaFond, L. A., *Tappi* 36, No. 8: 131–132A (1953); *B.I.P.C.* 24: 55 (1953).

Following a $3^1/_2$ years' operating period with ammonia-base sulphite liquor at the Lebanon, Ore., mill of Crown Zellerbach, the following comparison in cost and operating experience is made. Ammonia-base sulphite liquor doubled the cost over calcium-base liquor, but resulted in more uniform acid-plant and digester-house operation, a saving of about 40 lb. of sulphur per ton of pulp, increased pulp yield, increased production on account of shorter cooking cycles, an easier-screening pulp with a decrease in the percentage of screenings, and less maintenance. One problem which was not anticipated is the rapid growth of slime because of the higher nitrogen content.

Hull, J. H., *Pulp and Paper* 27, No. 9: 68, 71–72 (1953); cf. *B.I.P.C.* 24, 55–56; *B.I.P.C.* 24: 317 (1953).

The author summarizes the pilot plant work, with the evaporation, burning and sulphur recovery from ammonia-base waste liquor at the Lebanon, Ore., mill of Crown Zellerbach Corp. and describes the full-scale plant based on the pilot-plant design. The latter, however, has not been operating a sufficiently long time to obtain any reliable data; the flow-sheets for both are essentially the same. The waste liquor is collected in a sump and pumped to a storage tank, and from there to the evaporator. The pilot plant used a single-effect evaporator and the full-scale plant uses one with two effects. From here, the liquor with 50% solids flows to a storage tank from where it is pumped to a smaller tank which supplies the two boilers under which the liquor is burned in steam atomizing burners. One of the boilers is equipped for sulphur recovery; the system consists of one cooling and two absorption towers. An 80 to 85% sulphur recovery is expected from the new installation, also the provision of sufficent steam to cover the evaporating operation.

BINDING MATERIALS

Hurtubise, J. E., *Roads Eng. Construction* 90, No. 11: 190–192 (1952); *C.A.* 47: 8985 (1953).

A series of unconfined compression and absorption tests on Lignosol-treated gravel indicated a definite increase in compressive strength with the addition of 2% by weight of Lignosol, while absorption of water was noticeably reduced.

Wiley, A. J., Sherman, W., Bablick, G., Rice, N., Dickerman, G. I., and Collett, G., *Tappi* 36: 162–165 (1953); cf. *C.A.* 46: 4225 (1952); *C.A.* 47: 11727 (1953).

Sulphite waste liquor of blow-pit strength has been found useful in reworking worn black-top roads. After the old surfaces have been scarified and broken up, sulphite waste liquor was added at the rate of about 1.5 gal. per sq. yd. and the road was graded. After a few days of traffic the surface of the road consolidated to resemble the original light black-top treatment. Some of these reformed surfaces have been in service for over a year.

Hurtubise, J., *Can. Chem. Processing* 37, No. 2: 58, 60–61 (1953); *B.I.P.C.* 23: 509 (1953).

The author discusses results obtained by the addition of Lignosol to road gravel in the province of Quebec. In laboratory experiments a definite increase in the bearing capacity and compressive strength of Lignosol-treated gravel of different kinds could be noticed. In surfacing old roads, a layer of at least 3-in. gravel was treated with Lignosol (about 0.6 gal. per sq. yard) and after a drying-out period of approximately 24 hr., the surface was covered with a bituminous concrete. The additional strength imparted to the gravel allowed a reduction of 0.5 in. in the thickness of paving material, thus offsetting the cost of the treatment. This method has been used extensively on many hundred miles of roads with very good results. The problem of how much Lignosol is left in the soil after a number of years cannot be answered by direct measurement of soil samples, because no sufficiently sensitive methods are yet available. However, field observations indicate that even if Lignosol in its original form has been leached out, something is left behind which exerts beneficial effects on the surface properties of the particles in the soil system, so that higher shearing strength, less absorption of moisture, and increased density of the soil result. Frost heaving in a stratum of silt could be prevented by the injection of Lignosol. The testing program on the optimum conditions of Lignosol applications continues. The present data indicate that, wherever local conditions warrant it, excellent results may be obtained in the construction of base courses with adequate compaction of mixed-in-place gravel containing 2% of the waste liquor and the required optimum moisture content. This method would even permit the use of gravel under cold-climatic conditions where its application would not be possible otherwise.

Wiley, A. J., Sherman, W., Bablick, G., Rice, N., Dickerman, G. K., and Collett, G., *Tappi* 36, No. 4: 162–165 (1953); cf. *B.I.P.C.* 22: 360; *B.I.P.C.* 23: 673 (1953).

Reformation of worn asphalt or "blacktop" road surfaces has been found to be promoted by inexpensive applications of sulphite waste liquor during regrading operations. Practical road tests in Wisconsin have shown that secondary roads in advanced stages of raveling can be reworked with a grader to pulverize and redistribute the old surface material, after which sulphite waste liquor applications from tank trucks serve to accelerate the formation of a new, tight, bituminous-type surface within a few days under normal traffic. Such reformed surfaces, without use of new asphalt-binding material, have been observed to stand up well after a year of service in a northern Wisconsin winter and without apparent damage from spring breakup. Methods used in the road trials to date are described. Laboratory trials are being carried out to conform the reformation characteristics of sulphite liquor application to test material taken from old roads. Deformation and shear tests are in progress. Preliminary strength tests (Marshall stability) which have so far been completed, tend to confirm the experience of the road trials in terms of good load-bearing capacity. Some observers are of the opinion a transitional and preliminary softening reaction of the broken asphalt aggregate occurs after the application of sulphite waste liquor. Such a reaction might contribute in part to the reformation characteristics, but laboratory evaluation of this phenomenon has been difficult to carry out and to confirm.

Weleber, F. J., Proc. Fourth Ann. Ind. Waste Conf., State Coll. of Washington 33–35 (1952); *B.I.P.C.* 24: 318 (1953).

Experiments with sulphite waste liquor on county roads in Clackamas County, Ore., are described. The treatment varied from light applications for dust control to heavier treatments for consolidating the road; the results were in general satisfactory. Treatment with liquor prior to a one-lift oil application proved to be one of the unexpected successes of the work. Compaction, gradation of road aggregate, and cost of treatment are discussed briefly.

CHEMICALS

Vanillin

Fisher, J. H., and Marshall, H. B., Brit. pat. 683,093–4 (Nov. 19, 1952); *C.A.* 47: 3566 (1953).

See U. S. pat. 2,576,752–3 (*C.A.* 46: 2803 (1952)).

Fisher, J. H., and Sankey, C. A., Brit. pat. 683,095 (Nov. 19, 1952); *C.A.* 47: 3566 (1953).

See U. S. pat. 2,576,754 (*C.A.* 46: 2803 (1952)).

Kin, Z., *Przeglad Papier.* 9: 236–241 (1953); *C.A.* 47: 12806 (1953).

Sulphite waste liquor (after fermentation) is hydrolyzed in an alkaline medium, oxidized with air in the presence of copper sulphate, and acidified to pH 5.5 to 6.6. This produces crude vanillin (70 to 80% purity), which is extracted with toluene or xylene, then purified by distillation under vacuum of 2 mm. Hg at 112 to 120°, and recrystallized from H_2O acidified with 4% H_2SO_3. This gives small, white crystals of 99% purity. After vanillin has been extracted, lignin and sodium sulphate are isolated from the liquor.

Bland, D. E., Hillis, W. E., and Williams, E. J., *Australian J. Sci. Research Ser. A.* 5, No. 2: 346–367 (1952); *B.I.P.C.* 23: 332 (1953).

A theoretical investigation of the separation of pairs of solutes in a countercurrent distribution train has been made. The results are presented as families of curves from which may be read the number of transfers necessary to effect a 95 or a 99% separation of a pair of substances of known partition coefficients. The applicability of the curves has been verified when used to predict the number of transfers necessary for the separation of aromatic aldehydes from the oxidative decomposition of lignins. No relation between R_F value and partition coefficient could be established for the solvents investigated.

Leopold, B., *Svensk Papperstidn.* 55: 816–819 (1952); *B.I.P.C.* 23: 332 (1953).

The influence of methylation of lignin with various reagents on the yield of vanillin obtained on subsequent oxidation with nitrobenzene and alkali has been studied. It is shown that methylation with dimethyl sulphate and alkali—in contrast to methylation with diazomethane or methanol and hydrogen chloride—causes a decrease in the yield of vanillin of up to 90% in the case of unsulphonated lignin. Methylated lignin-sulphonic acids, on the other hand, give vanillin yields which are only 20 to 30% lower than those obtained from the original material. This effect is probably caused by the inhibition of alkaline splitting of the phenolic ether linkages in lignin which results from the methylation of benzyl alcoholic and phenolic hydroxyl groups. This viewpoint is supported by studies of suitable benzyl methyl ethers which yield almost no vanillin on nitrobenzene oxidation.

Newcombe, A. G., and Reid, S. G., *Nature* 172, No. 4375, 455–456 (1953); *B.I.P.C.* 24: 97 (1953).

Vanillin, acetovanillone, veratraldehyde, and acetoveratrone were effectively separated by spotting on paper previously sprayed with dilute sodium bisulphite solution and dried and developed with the organic phase produced by mixing 9 volumes of hexane, 1 volume of chloroform, and 10 volumes of water. Acetoveratrone had the highest R_F value followed, in order, by acetovanillone, veratraldehyde, and vanillin. The use of treated papers for other separations is discussed.

Anon., *Dow Diamond* 16, No. 4, 16–19 (1953); *B.I.P.C.* 24: 231 (1953).

Mention is made of the research program of the Ontario Paper Co., Thorold, Ont., which led to the manufacture of alcohol from sulphite waste liquor and to vanillin from the sulphite waste from which the fermentable sugars have been removed. The Dow Chemical Co. markets the pure vanillin produced by the Ontario Paper Co.

Bryan, C. C., Can. pat. 496,147 (Sept. 15, 1953); *B.I.P.C.* 24: 255 (1953).

A process for the recovery of vanillin in high yield and purity from a crude concentrate using a liquid aliphatic hydrocarbon as a distilling aid is claimed. This corresponds to U. S. pat. 2,506,540 (May 2, 1950); cf. *B.I.P.C.* 20: 768–769.

Other Phenolic Compounds

Pearl, I. A., and Dickey, E. E., *J. Am. Chem. Soc.* 74: 614–617 (1952); cf. *C.A.* 45: 2664, 5657 (1951); *C.A.* 47: 9945 (1953).

Because the complex nature of fractions obtained by oxidizing lignin-sulphonate materials with copper oxide and alkali precludes their complete analysis by heretofore employed procedures, recourse was made to adsorption chromatography. By means of this technique, the $NaHSO_3$-soluble and the alkali-soluble fractions from such oxidations have yielded the following new oxidation products: 4,4′-dihydroxy-3,3′-dimethoxy-chalcone, m. 118–120°; (2,4-dinitrophenylhydrazone, m. 290–295 (decomposition); diacetate, m. 136–137°); 4,4′-dihydroxy-3,3′-dimethoxybenzil, m. 230–231.5° (diacetate m. 138–140°); 4,4′-dihydroxy-3,3′-dimethoxybenzophenone, m. 155–156° (diacetate, m. 148–149°; 2,4-dinitrophenylhydrazone, m. 235–237°); and an unidentified isomer of dehydrodivanillin, probably a dihydroxydimethoxyformylbenzophenone, m. 178.5–179.5° (diacetate, m. 135–136°). Chromatography of a C_6H_6 solution of the alkali-soluble fraction yielded guaiacol, acetovanillone, vanillin, vanillil (4,4′-dihydroxy-3,3′-dimethoxybenzil), m. 230–231.5°, and 4,4′-dihydroxy-3,3′-dimethoxybenzophenone. All melting points uncorrected. Although the isolation of these products can be explained by assuming their resynthesis from vanillin or a similar compound originally formed by the degradation of the lignin, there is also a possibility that some of the C_6-C_6 units in the lignin structure are linked together through the α-C atoms. Ultraviolet absorption spectra are given.

Monnberg, R., Ora, A., and Lehmuskoski, U., *Paper and Timber* (Finland) 35, No. 1, 8–12 (1953); *Svensk Papperstidn.* 56, No. 2: 46–49 (1953); cf. *B.I.P.C.* 19: 777; *B.I.P.C.* 23: 510 (1953).

In a previous article one of the authors described a precipitate obtained from sulphite waste liquor or fermented sulphite waste liquor by treatment with lime. When this precipitate was diluted with hydrochloric acid and washed with slightly acid water, a lignin was isolated which was called "Rauma lignin." When Rauma lignin was treated with methyl alcohol and lime at a temperature of 350°C. and a pressure of about 600 atm., a substance resulted from which a white phenol could be isolated by distillation *in vacuo*. This phenol was called "Rauma phenol" and has been fully identified as pentamethylphenol. The yield of Rauma phenol has been improved by treating Rauma lignin with lime and methyl alcohol at temperatures above 300°C. without addition of water. The yield of raw Rauma phenol amounted to about 19% and that of comparatively pure Rauma phenol to 7% based on dry Rauma lignin. Rauma phenol obtained from Rauma lignin

as well as synthetic pentamethylphenol has given duroquinone on oxidation with chromic acid. This reaction is covered by U. S. pat. 2,608,561 granted to Monnberg and Ora (Aug. 26, 1952); cf. *B.I.P.C.* 23: 529.

Monnberg, R., and Ora, A., U. S. pat. 2,608,561 (Aug. 26, 1952); cf. *B.I.P.C.* 23: 510 (1953); *B.I.P.C.* 23: 529 (1953).

A method of preparing duroquinone by oxidation of pentamethylphenol, (obtained as a degradation product of sulphite waste liquor) with potassium or sodium bichromate in the presence of sulphuric acid is claimed.

Monnberg, R., *Paper and Timber* (Finland) 35, No. 4: 189–199 (1953); *B.I.P.C.* 23: 888 (1953).

By treating lignin quite drastically with lime and methanol, a crystalline degradation product is formed. This is identified as pentamethyl phenol. On oxidation, pentamethyl phenol yields duroquinone (cf. *B.I.P.C.* 23: 510, 529), the structure of which is shown by its synthesis from durene. The dihydro derivative of duroquinone bears a certain structural relationship to vitamin E, which is discussed briefly. Structural formulas are given, showing various stages of this methylation starting with the cresols and ending with pentamethyl phenol) indicating that as many as 19 methylated monohydric phenols are possible.

Sulphite Turpentine

Kleinert, T., *Monatsh.* 83: 1009–1010 (1952); *C.A.* 47: 1385 (1953).

The reaction of α-pinene with soluble lignin was studied. Under strongly acid conditions at 120 to 150°, α-pinene gives up some of its hydrogen to soluble lignin and is converted to *p*-cymene. The dehydrogenating action of soluble lignin is strongly pH dependent and is very likely the reason for a terpene to *p*-cymene transformation when conifers are treated with strongly acid sulphite liquor. Under alkaline conditions, no such reaction occurs.

Grabowksi, J., *Przeglad Papier* 8: 271–273 (1952); *C.A.* 47: 2984 (1953).

The apparatus for the recovery of cymene during the relief of the sulphite digester is installed between the digester and the sulphur dioxide-storage tank. The process consists of condensing sulphur dioxide, steam and cymene vapours, separating raw cymene from the condensate, conducting the condensate to the sulphur dioxide tank and cymene to a mixing tank, adding about 20 grams $Ca(OH)_2$ per 1 kg. of cymene, distilling the mixture with steam, condensing, cooling, and separating the upper layer consisting of pure cymene from water.

Smirnow, A., *Przeglad Papier*, 9: 44–45 (1953); *C.A.* 47: 5680 (1953).

Digester relief gases containing sulphite turpentine are cooled to 35 to 40° and passed through a special iron separator lined with acid-resistant tiles and packed with acid-resistant bricks and Raschig rings. The noncondensable gases escape through the top, and the condensate, containing sulphite turpentine is collected at the bottom. The condensate is sent to a tank where sulphite turpentine is separated from H_2O and cooking liquor, treated with H_2SO_4 at 66° Bé., washed with H_2O, neutralized with $(NH_4)_2CO_3$, steam-distilled, fractionated, and dried over $CaCl_2$. This gives a pure *p*-cymene.

Smirnow, A., *Przeglad Papier* 9: 18–25 (1953); *C.A.* 47: 6135 (1953).

Laboratory experiments indicate that the presence of *p*-cymene during cooking adversely affects the quality of pulp by increasing its pitch content, decreasing its pentosan content, and lowering its brightness; it also lengthens somewhat the cooking time. The isolation of *p*-cymene during the sulphite pulping process and its utilization as a raw material in the chemical industry are emphasized.

EMULSIFYING AND DISPERSING AGENTS

Soma, R., Jap. pat. 7737 (Dec. 18, 1951); *C.A.* 47: 5090 (1953).

Rosin (1 ton) is saponified with 70 kg. 28% NH_4OH for 30 min. at 120 to 190°; the product is mixed with sulphite waste pulp liquor (1:0.5). The mixture is made slightly alkaline and diluted with 10 parts water, 10 liters. of which is mixed with a ton of cement to make an air-included product.

Skalicka, A., *Przeglad Papierniazy* 9: 142–144 (1953); *C.A.* 47: 10223 (1953).

Applications of sulphite waste liquor in the manufacture of cement and concrete are reviewed.

EVAPORATION AND BURNING

Ramen, T., Swed. pat. 135,194 (April 8, 1952); *C.A.* 47: 320 (1952).

An apparatus for drying sulphite waste liquors is described.

Wilcoxson, L. S., U. S. pat. 2,619,411 (Nov. 25, 1952); *C.A.* 47: 864 (1953).

An incinerator for recovering the incombustible residue and heat from sulphite waste liquor is described.

Brunes, B., *Wochbl. Papierfabr.* 80: 864–870, 923–929 (1952); *C.A.* 47: 2483 (1953).

An illustrated lecture on the recovery, evaporation, and burning of sulphite waste liquor.

Dinsmore, R. F., *Paper Mill News* 76, No. 7: 14, 16–20 (1953); *C.A.* 47: 6134 (1953).

Following a literature survey on long-tube evaporators in general, Dinsmore describes the construction and operation of a new evaporator (designed by L. Jenness and Joseph Meisler) together with the experimental procedures used in evaporating ammonia-base sulphite waste liquor. The advantages claimed are simplicity, steadiness of operation, and no foaming, except during a warm-up period. Heat losses from the evaporator were negligible. When water was evaporated in the evaporator, the heat-transfer coefficients increased with increasing temperature differences. In the concentration of ammonia-base sulphite waste liquor, over-all coefficients decreased. Heat flux densities for ammonia-base sulphite waste liquor average 64% higher than did similar figures reported for soda black liquor in a similar type of evaporator. Coefficients obtained for water ranged from 271 to 410 B.t.u. per hr., per sq. ft., per °F. temperature difference. Over-all coefficients obtained for ammonia-base sulphite waste liquor varied from 164 to 296 B.t.u. per hr., per sq. ft. per °F.

Malcove, N. L., *Paper Mill News* 76, No. 12: 114–115, 130 (1953); *C.A.* 47: 6135 (1953).

A descriptive article deals with the collection and evaporation of waste liquor, and the precautions required in burning liquors concentrated to 50 to 60% total solids. Atomization (preferably with steam) is carried out with liquor preheated to 200°F.; this greatly reduces the viscosity of the solution. The composition and particle-size classification of fly ash and suitable fly-ash-removal equipment are discussed.

Kann, F., *Das Papier* 7: 62–64 (1953); *Papier, carton, et cellulose* 1, No. 6: 66–68 (1953); *C.A.* 47: 6654 (1953).

A brief description of Vermeiren's "CEPI" electromagnetic system as installed in piping through which waste calcium-base beechwood sulphite liquor is fed to a Ramen quadruple-effect vacuum evaporator. The effects of Vermeiren's "CEPI" electromagnetic system were found weakest in areas remote from the source of activation. When Vermeiren's "CEPI" electromagnetic system was used, sludge, when

formed even in large amounts, could be removed easily by flushing with H_2O (in contrast to the persistent crystalline scale formed without use of Vermeiren's "CEPI" electromagnetic system).

Edling, G., *Das Papier* 7: 159–164 (1953); *Svensk Papperstidn.* 55: 863 (1952); *C.A.* 47: 7212 (1953).

Kraft mills, when carefully operated, can produce sufficient fuel to maintain themselves (i.e., they can furnish heat equivalent to that given by 1200 kg. coal per ton of pulp). With sulphite mills the question cannot be answered categorically, although certain of these can also dispense with other fuel. In Sweden about 800,000 tons of coal was saved annually by the economic utilization of black liquors and sulphite waste liquor.

Ramen, T., Swed. pat. 139,118 (Feb. 10, 1953); *C.A.* 47: 7216 (1953).

Apparatus is described for the evaporation of sulphite waste cellulose liquors with direct steam heating in two or more stages with increasing temperature between stages. The liquor from the final stage is cooled by reduction of pressure, and the steam liberated is reused in the earlier stages. Cf. *C.A.* 45: 2207 (1951).

Collin, P. H., Swed. pat. 139,205 (Feb. 17, 1953); *C.A.* 47: 7216 (1953).

Cellulose sulphite waste liquors are subjected to heating under pressure to at least 120°, after first adding alkali sulphate in amounts corresponding to 35 to 150 kg. per ton. The liquor is then conveniently expanded into a vessel at a lower pressure and can be evaporated without difficulties due to crust formation.

Edwardes, V. P., *Paper Trade J.* 136, No. 9: 14–18 (1953); *Paper Mill News* 76, No. 18: 12, 16 (1953); *C.A.* 47: 8367 (1953).

Chip packing and indirect heaters are necessary to obtain sulphite waste liquor at the optimum concentration of 20% solids, which can be obtained by controlling the amounts of relief and by the re-use of sulphite waste liquor in the cooking liquor. Impregnation of the chips with liquor of double the normal concentration, withdrawing some, and leaving enough for circulation will also give sulphite waste liquor of high concentration up to 75% of undiluted. Sulphite waste liquor can be recovered from the blow pits and, under certain conditions, 90% of the solids can be recovered in a liquor of concentration 2% below that of the original. The CEPI method of treating sulphite waste liquor (cf. *C.A.* 47: 6138 (1953)) is described. The channel-switching type of evaporator has been the most successful, but the thermal-compression type shows promise. The best concentration of solids for burning is 55 to 57%. Satisfactory methods of burning concentrated sulphite waste liquor with or without powdered coal or fuel oil are described. The Loddy auxiliary and the Lenzinger furnaces are described with diagrams. In burning calcium-base sulphite waste liquor the problem of fly ash and sulphur dioxide remains unsolved.

O'Donoghue, J. P., Jr., Goddard, H. O., and Helleur, D., *Pulp Paper Mag. Can.* 54, No. 3: 230–238 (1953); cf. *C.A.* 44: 6120 (1950); *C.A.* 47: 9613 (1953).

Changes from previously reported operations include a third heater, acid steam condensers to provide acid condensate for condenser descaling, and a specific electric conductance controller for controlling changes in the liquor. By shift washing of the heaters, week-end washing of the whole system with acid condensate, and periodic washing with 2 to 3% HNO_3 the system can be made 90% free of scale. Scale was partly calcium sulphate and partly organic matter. At a 25% solids concentration, calcium sulphate predominated and at 50% solids as high as 20% organic matter was found. Four flow diagrams show means of adapting this pilot plant study to full scale operation.

Cunningham, G. L. U. S. pat. 2,644,748 (July 7, 1953); *C.A.* 47: 9617 (1953).

A pulping process is described in which the calcium is removed from the waste liquor as $CaSO_3$ and $CaCO_3$, permitting evaporation of the waste liquor. The concentrated liquor can then be burned, producing SO_2 for recycle and a residue of MgO which is low in calcium. The wood is pulped with a solution of $Ca(HSO_3)_2$ and $Mg(HSO_3)_2$, prepared by passing SO_2 through a suspension of ground dolomite. A typical waste liquor contains (g./1) 115 total solids, 9.64 ash, 7.83 total sulphur, and 0.76 sulphur as SO_3. $CaSO_3$ is precipitated by neutralizing the waste liquors with dolomite. After filtration, complete removal of the calcium as $CaCO_3$ results when the liquor is made alkaline with burned dolomite (CaO and MgO) and then carbonated with CO_2 to a pH of 9.0 to 9.3. The MgO added should be such that the total moles of magnesium exceeds the total moles of calcium, preferably by 10% of the total calcium and magnesium ions present. The calcium-free liquor can then be concentrated without difficulty and burned. Alternately, the concentrate can be processed to yield the Mg as a carbonate or hydroxide precipitate permitting the organic residues to be used for lignin derivatives, fermenting liquors, etc. Cf. *C.A.* 44: 11045 (1950).

Novak, P. T., U.S.S.R. pat. 77,938 (Dec. 31, 1949); *C.A.* 47: 10228 (1953).

To remove scale from evaporators primarily in sulphite liquor fermentation plants, the scale is acted upon by a hot aqueous solution of 2-naphthalene-sulphonic acid to which is added sodium chloride.

Scholander, A., *Norsk Skogind.* 4: 63–71 (1950); *Chem. Zentr.* 1950, II: 1299–1300; cf. *C.A.* 44: 9148 (1950); *C.A.* 45: 7351 (1951); *C.A.* 47: 11728 (1953).

The extraction of waste liquor by displacement is treated mathematically on the basis of experimental results (Central Laboratory of the Cellulose Industry, Stockholm). The terms "dry-substance yields" and "concentration quotient" are discussed along with their significance to the economic aspects of alcohol production, waste liquor concentration, and a combination of both. Economy of operation is increased by improved displacement in the digester through the use of hot water at 50° or, better, at 125°. This effect is studied with a 40-liter laboratory digester filled with glass wool, salt solutions of varying density, and waste liquor. In displacement with weak liquors or waste wash, difficulties are encountered because of canal formation when the density of these liquors is greater than that of the liquor being displaced. An increased sulphate ion content in waste liquor increases the encrustation during distillation and evaporation, so these processes must be carried out at the highest possible temperature in order to avoid resolution of the gypsum upon cooling.

Edling, G., *Svensk Papperstidn.* 55: 863–868 (1952); *B.I.P.C.* 23: 328 (1953).

The author discusses the possibilities for Swedish sulphate and sulphite mills to cover their fuel requirements through the recovery and combustion of their waste liquors. Heat balances are presented based upon data gathered by the Swedish steamboiler association during recent years. Emphasis is placed upon the fact that a successful solution does not depend only upon local conditions, modernized mills, and new installations, but upon the regular strict control of the entire heating process. New possibilities for heat savings must constantly be sought. Sulphate mills are in a better position to become self-supporting than sulphite mills although, under certain favorable conditions, the latter might also achieve this goal. By the efficient use of the waste liquors, the author estimates that the Swedish pulp industry might save 800,000 tons of coal per year.

Rhinelander Paper Co., *Paper Trade J.* 135: 11–12, 14 (1952); *Paper Ind.* 34: 1074–1076 (1952); *Chem. Eng. News* 30: 5196 (1952); cf. *B.I.P.C.* 23: 246; *Chem. Eng.* 60, No. 3: 140–142, 144 (1953); *B.I.P.C.* 23: 36 (1953).

With reference to the recent installation of Rosenblad channel-switching evaporators by the Lake States Yeast Corp., a subsidiary of Rhinelander Paper Co., the processing of the desugared lignin solution left after yeast fermentation is described. The desugared lignin solution is evaporated to a sirupy consistency containing 50% solids. This concentrate is stored in two 10,000-gal. tile tanks and may be pumped in any of three directions: to driers for production of 94% dry solids, to a dock for loading tank cars or tank trucks, or to the boiler house for utilization as fuel. The desugared solids, whether in the dry or 50% concentrate form will be marketed under the trade name "Toralig." Principal uses are as adhesives, dispersants, and chemical raw materials. Whatever fraction remains unsold at any time will be piped in 50% concentration to the Rhinelander Paper Co.'s boiler room for burning as industrial fuel; this, however, will be only the last resort to prevent discharge of the liquor into the river.

Badger, W. L., and Lindsay, R. A., *Ind. Eng. Chem.* 45, No. 1: 55–58 (1953); cf. *B.I.P.C.* 22: 403; *B.I.P.C.* 23: 403 (1953).

The literature of the past year on the theory and practice of evaporation is reviewed. Part of one section in the article is devoted to the literature published on the evaporation of black liquor and waste sulphite liquor.

Becker, F., *Pulp & Paper* 27, No. 1: 63–64 (1953); cf. *B.I.P.C.* 23: 360; *B.I.P.C.* 23: 403 (1953).

Essentially the same information as in the previous reference concerning the new evaporator plant at Rhinelander is given.

Simmons, T., *Svensk Papperstidn.* 56, No. 4: 121–123 (1953); *B.I.P.C.* 23: 585 (1953); *Pulp Paper Mag. Can.* 55, No. 1: 108–110 (1954).

The development of a cyclone burner for the firing of sulphite waste liquor at the Loddby mill of Holmens Bruks & Fabrik AB is described. The burner involves a normal boiler type with water-cooled furnace walls suitable also for the firing of other fuels and special combustion changers for the waste liquor outside the furnace proper. The liquor is fed under pressure through atomizers into a cylindrical, brick-lined muffle with the atomizer at one end of the cylinder. Air intakes along the greater part of the muffle force the liquor drops sprayed in the form of a hollow cone toward the circumference where the concentration of oxygen is highest and conditions for burning are most favorable. Drying and ignition take place outside the furnace. The liquor particles, whenever they strike the walls, must be so dry that they will not stick. The ash has been allowed to pass with the flue gases into and through the furnace. Most of it goes with the flue gases to the dust collectors, from where it is shoveled away every Sunday, mixed with water to form a slurry, and pumped away. No difficulty should be experienced in a boiler fitted with soot blowers. The ash is pure white and contains no organic matter. When the wood is transported by land, the ash shows no tendency to cake; wood floated to the mill in salt water will give an ash with a certain tendency to cake to the tubes. However, the deposits are very brittle and easily dislodged by light tapping. The operation of the first units at Loddby was so successful that a new boiler is now under construction; it is a La Mont type with a water-cooled sloping grate for firing wood refuse and two cyclone burners for the waste liquor. The patent rights of the invention have been assigned to AB Rosenblads Patenter in Stockholm. Several other Swedish mills have already installed or are in the process of installing the new cyclone burner; some of these are designed to be used in conjunction with oil or coal.

Lindsey, E., *Chem. Eng.* 60, No. 4: 227–240 (1953); *B.I.P.C.* 23: 635 (1953).

The author discusses the standard types of evaporators most used today (climbing-film, long-tube vertical type or Kestner evaporator; forced-circulation type; and falling-film, long-tube vertical type) and some units which have recently come into commercial use, including the Turba-Film evaporator, flashing evaporators, and the Rosenblad switching evaporator for scale-forming liquors (waste sulphite liquor). Other methods of evaporation (solar evaporation, jacketed kettles, submerged combustion, and use of electrical energy) are mentioned briefly; methods used to save energy, costs, separators, and new instruments are also considered.

Vermeiren, Th., *C.E.P.I. Assoc. tech. ind. papetière, Bull.* No. 1: 7–15 (1953); cf. *B.I.P.C.* 23: 551 (1953); *B.I.P.C.* 23: 673 (1953).

Following a brief discussion of hard water and heat losses resulting from scale, the author outlines the effects of magnetic fields, the vibration of which serves to prevent crystallization of dissolved salts which destroy intramolecular cohesion and which may gradually cause the breakdown of previously formed incrustations. The greater part of the article is devoted to a description of the author's automatic apparatus CEPI, its operation and uses in the pulp and paper industry, especially in the pretreatment of sulphite and alkaline cooking liquors, waste cooking liquors, bleach liquors, etc. to prevent the formation of harmful deposits on the surfaces of machinery.

Singleton, J. C., Jr., U. S. pat. 2,636,813 (April 28, 1953); *B.I.P.C.* 23: 761 (1953).

A furnace with two or more discharge nozzles directed downward at such an angle that a combustion zone is maintained just above the hearth provides an efficient means of chemical and heat recovery from waste liquors (sulphite waste and black liquor, especially from the soda process). The atomizer nozzle is claimed to be nonplugging and so constructed that the materials are ejected in a horizontal flat spray. Regulation of air to the furnace and steam to the atomizer nozzles is employed to control the depth of the char on the hearth. The smelt is recovered continuously from the hearth in a molten state.

Anon., *Paper Mill News* 76, No. 18: 7–8 (1953); *B.I.P.C.* 23: 803 (1953); *Taylor Technol.* 6: 3–7 (1953); cf. *B.I.P.C.* 23: 803.

The Rosenblad reversible-flow, quadruple-effect evaporator has been placed in operation at the Interlake mill of Consolidated Water Power & Paper Co., Appleton, Wis. The installation is expected to handle the mill's entire supply of collectible sulphite waste liquor from nine Mitscherlich digesters at approximately 13.3% solids content and to concentrate it to 60% solids for use as a boiler fuel. The experience gained at Appleton will be used in making plans for processing the sulphite waste liquor in the company's considerably larger sulphite mill at Wisconsin Rapids.

Darmstadt, W. J., and Richter, F. H., *Tappi* 36, No. 6: 171–174A (1953); *B.I.P.C.* 23: 829 (1953).

With the development of suitable evaporators, the concentration of sulphite waste liquor is now practical, and disposal may be accomplished by burning with recovery of the heat value of the liquor. Under proper conditions a considerable reduction in the amount of fuel purchased by the mill will result, and these fuel savings are available to offset the capital and operating costs of the disposal system. The fuel savings depend on the amount of fuel saved and the local price of commercial fuel. Chemical recovery, in addition to heat recovery, will reduce the chemical costs and increase the possible savings from burning. The authors discuss some of the economic factors bearing on heat and chemical recovery and describe

some of the problems incident to the burning operation. Since considerable investment in equipment will be required to collect, evaporate, and burn the liquor, the savings in fuel and chemical must be evaluated against the investment and increased operation costs to determine the over-all economics of disposal by burning. Conditions will vary from mill to mill, and an economic study should be made by each plant before deciding on liquor disposal by burning. The unit cost of equipment and operation will decrease with increasing capacity or mill size; partial disposal of liquor will require less expensive installations than complete disposal.

Anon., *Wochbl. Papierfabrik* 81, No. 11: 374–376 (1953); *B.I.P.C.* 24: 191 (1953).

The advantages of vacum evaporators (usually in the form of multiple-effect evaporators) for handling sulphite waste and black liquors are described.

Sadler, H., Bellak, F., and Roder, H., *Das Papier* 7, No. 21/22: 416–424 (1953); *B.I.P.C.* 24: 320 (1953).

On laboratory experiments, the waste liquors from spruce sulphite and sulphate cooks (including all wash waters) were quantitatively separated from the pulp and concentrated, and the fuel value of each was established. The purpose of the study was the determination of the influence of the ash content in sulphite waste or black liquor upon the respective fuel values. Black liquor contains more inorganic substances than sulphite waste; hence its fuel value is up to 30% lower. The following mean values were established for the fuel value of the water-free dry substance of both liquors: black liquor maximum 3450 and minimum 3250 kg.-cal. per kg.; and waste sulphite maximum 4370 and minimum 4170 kg.-cal. per kg. However, under drastic cooking conditions—assuming the identical cooking degree of pulp, a lower pulp yield is obtained with sulphate cooks with more organic substance dissolved in black liquor than in sulphite waste, so that under these conditions black liquor gives a higher fuel value than sulphite waste liquor. The relationship between fuel value, ash content, and water content of the waste liquor has been established.

FERMENTATION

Miwa, M., *J. Fermentation Technol.* (Japan) 30, No. 10: 297–300 (1952); *C.A.* 47: 2425 (1953).

A review of yeast production from sulphite waste liquor.

Yamada, K., *J. Fermentation Assoc.* (Japan) 7: 219–223 (1949); *C.A.* 47: 2426 (1953).

An address on the manufacture of yeasts from waste sulphite liquor with the Waldhof fermentor.

An address on the fermentation of sulphite waste liquor.
Yamada, K., *J. Fermentation Assoc.* (Japan) 8: 341–343 (1950); cf. *C.A.* 46: 10530 (1952); *C.A.* 47: 2426 (1953).

Suzuki, T., *Hakko Kyokai Shi* (*J. Fermentation Assoc.*) 7: 59–62 (1949); *C.A.* 47: 3513 (1953).

Most of the sulphur dioxide contained in the sulphite waste liquor is separated in the gas-separation tower, and the remainder is neutralized with lime. After the addition of $(NH_4)_2SO_4$, superphosphate of lime, and yeast, the waste is fermented into mother yeast. Then 1 part of mother yeast is mixed with 6 parts of sulphite waste liquor and is ripened into ripe mash from which alcohol is distilled. The alcohol obtained contains MeOH 0.7 and AcH 0.01%.

Day, Wm. C., Gottlieb, S., and Pelczar, M. J., *Appl. Microbiol.* 1: 78–81 (1953); cf. *C.A.* 46: 8189 (1952); *C.A.* 47: 4952 (1953).

While *P. versicolor* (grown in surface culture) apparently did not metabolize sodium ligninsulphonate when it was the sole carbon source in a saltsthiamine medium, adsorption of the sodium ligninsulphonate on the mycelium was observed when the mold was grown on the basal medium supplemented with glucose.

Gamble, S. J. R., and Butler, R. G., *Appl. Microbiol.* 1: 96–97 (1953); *C.A.* 47: 5115 (1953).

Bacteria utilizing neutralized sulphite waste liquor were isolated from soil samples perfused with the liquor.

Schoedler, K., *Wochbl. Papierfabrik* 81: 44–46 (1953); *C.A.* 47: 6597 (1953).

The advantages of Me_2CO-BuOH fermentation of waste sulphite liquor (especially those from beechwood) are stressed. Me_2CO-BuOH fermentation is advantageous when waste sulphite liquor contains largely pentoses which cannot be fermented to EtOH by yeast. Pilot-plant studies at Tonesch indicated the economics of the process from a German mill producing 40,000 to 50,000 tons, with half coniferous and half beechwood; the results are compared with those of yeast fermentation of coniferous sulphite waste liquor alone. Me_2CO-BuOH fermentation is favored; BuOH and Me_2CO are in greater demand than is sulphite EtOH.

Taketomi, N., Shiozawa, K., and Tanaka, S. J., *Chem. Soc. Japan, Ind. Chem. Sect.* 54: 660–662 (1951); *C.A.* 47: 7157 (1953).

Sulphurous acid was removed from sulphite waste liquor by steam-stripping. Calcium hydroxide was added to the liquor to pH 9.0. After filtration and neutralization with carbon dioxide, the liquor was cultivated with food yeasts or fodder yeasts. *Mycotorula japonica* was the most suitable for yeast production, the yield being 40% of the sugar consumed. Good results were obtained by acclimatizing the yeasts of the waste liquor.

Bujak, St., *Acta Microbiol. Polon.* 1, No. 1: 65–87 (1952); *C.A.* 47: 7157 (1953).

Investigations were made to utilize potato pulp and sulphite liquor, by-products in the potato meal and cellulose industries. Fermentation was carried out over a 12-hr. period by using the constant-flow method, a 35-liter reactor, and 0.6 cu. m. per hr. of air. The temperature was maintained at 30°, and the pH varied between 5.1 and 4.3. For every 100 grams of sugar 5.2 grams N and 3.8 grams P_2O_5 were added. The yeast thus produced was separated from the medium by centrifuging and dried *in vacuo*. Prior to fermentation the potato pulp was hydrolyzed at 134° (2 atm. pressure) with 0.5% H_2SO_4 and a 1:10 ratio of solids to water. The hydrolyzate was then filtered off, neutralized to a pH 4.5 with ammonia, enriched with potassium and magnesium salts, inoculated with yeast, and subjected to fermentation. The sulphite liquor contains free sulphur dioxide and other volatile substances which poison the yeast. To eliminate those the sulphite liquor was neutralized to pH 10 by slack lime. The precipitate formed was discarded, and the liquid was acidified to pH 4.5 with H_2SO_4. The addition of humic acids to the sulphite liquor resulted in higher yields (1.5%), probably owing to the colloidal nature of that substance. Fermentations were carried out with *Saccharomyces cerevisiae* and *Torula utilis*, and the results were compared with those of fermentation of molasses. The yields in per cent of sugar given and in per cent of sugar consumed were, respectively, for *Saccharomyces cerevisiae* from molasses (control) 40.4–41.2 and 43.7–44.2, from potato pulp 39.0–39.5 and 42.7–43.5, and from sulphite liquor (pH 10) 30.6–31.0 and 44.2–44.7; for *Torula utilis* from molasses (control) 47.5–48.1 and 52.3–52.8, from potato pulp 47.6–50.2 and 57.3–60.7, and from sulphite liquor (pH 5–10) 28.8–41.1 and 45.5–48.8. *Saccharomyces cerevisiae* contained 7.5–8.0% N and 4.5–4.6% P_2O_5; *Torula utilis* contained 8.9–9.5% N and 5.6–6.5% P_2O_5.

Gad, G. and Furstenau, E., *Das Papier* 7: 127–129 (1953); *C.A.* 47: 7211 (1953).

Critical examination of methods used for the determination

of total reducing sugars by means of Fehling solution showed that a modification of the Schwabe-Hahn technique (*C.A.* 43: 401 (1949)) gave satisfactory results. Details of the determination are given. The final $KMnO_4$ titration is carried out in the presence of H_3PO_4.

Celanese Corp. of America. Brit. pat. 689,412 (March 25, 1953); *C.A.* 47: 8312 (1953).

Propionic and acetic acids were obtained by fermentation of waste sulphite liquor with *Propionibacterium*. The waste liquor is steam-stripped to remove sulphur dioxide and concentrated to contain 20% total solids. Lime is added to adjust the pH to 7. Addition of nutrients (urea and dried-yeast extracts) increases the rate of fermentation by providing growth factors and nitrogen. After inoculation, fermentation is allowed to continue for 16 days at 30°. The organic acids are obtained by acidification and solvent extraction, the yield is 45% propionic and 16% acetic acids based upon the original weight of sugars present. This is 74% of theory, assuming all the sugars to be hexoses.

Boggs, L. A., *Anal. Chem.* 24: 1673–1675 (1952); *C.A.* 47: 8588 (1953).

A descending method of two-dimensional paper chromatography with available one-dimensional apparatus has been developed. By weaving a section of unsprayed chromatogram from the first solvent system into slits made in the paper for the second solvent system, the procedure eliminated the need for the large tanks usually employed. The presence of xylose, arabinose, mannose, glucose, and galactose and the absence of detectable amounts of fructose have been shown in waste sulphite liquor by using phenol saturated with water and EtOAc-AcOH-H_2O (9:2:2) as the solvent systems and a solution of *p*-anisidine (0.2 gram) and trichloracetic acid (1.0 gram) in H_2O (50 ml.) as the indicator spray.

Taketomi, N., Shiozawa, K., and Ueda, T., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 55: 19–22 (1952); *C.A.* 47: 10223 (1953).

Preparation of lactic acid by means of *Lactobacillus pentoaceticus* (cf. *C.A.* 47: 1328 (1953)) from the sulphite waste liquor containing pentosan was studied. Sulphur dioxide was removed by steam-stripping, and calcium hydroxide was added until the pH became 9.0. After filtration and neutralization with carbon dioxide, the liquor was inoculated with *Lactobacillus pentoaceticus*, nos. 43 and 64. Malt sprouts were used as nitrogen nutrients and the fermentation was carried out at 30° for 40 to 48 hr. The liquor, containing 2.0 to 3.3% calcium lactate and 0.5 to 0.8% Ca $(OAc)_2$, was concentrated, acidified, and extracted with AmOH. The extract was washed with H_2O and lactic acid was transferred into the aqueous phase. From the aqueous phase lactic acid of 90% purity was obtained.

Samuelson, O., and Sjostrom, E., *Svensk Kem. Tid.* 64, No. 11: 305–314 (1952); *B.I.P.C.* 23: 480 (1953).

A method of eliminating interference of nonsugar reducing substances in the estimation of reducing sugars in sulphite waste liquor is presented. Sulphite waste liquor is de-ashed by passage through a sulphonic acid resin column. An aliquot is diluted with ethanol to an ethanol concentration of about 95%, then passed through a column of a strongly basic resin in the bisulphite form, and the column is washed with 99.5% ethanol. The sugars are eluted with hot water and the eluate is passed through a strongly basic resin in the acetate form. Analysis of the effluent by the modified Schoorl method gave reducing sugar values somewhat lower (5 to 28%) than those obtained by the Swedish standard method CCA11 (cf. *B.I.P.C.* 15: 201–202). The sorption is believed to result from the formation of bisulphitelike addition compounds. The order of increasing sorption is: fructose, glucose, galactose, mannose—the same as the order of increasing stability of the bisulphite addition compounds. Common aldehydes are held more strongly than these sugars. Examples of fractionations of a fructose and mannose mixture in water, and of a fructose, glucose, and mannose mixture in 99.5% ethanol are given. The application to the practical analysis of sugar mixtures awaits further study.

Ahlen, L., and Samuelson, O., *Svensk Papperstidn.* 56, No. 3: 81–84 (1953); *B.I.P.C.* 23: 546 (1953).

The accuracy of the pycnometric determination of alcohol in sulphite waste liquor and condensates from sulphite waste liquor according to the Swedish standard method CCA12 (cf. *B.I.P.C.* 15: 367–368) has been investigated. The carbonyl compounds present in the distillate are shown to have only a negligible influence upon the results. Different factors which affect the determination of methyl alcohol by the chromotropic acid method have been studied. Interfering formaldehyde can be removed by means of ion exchange. However, the formaldehyde concentration in the distillates obtained according to CCA12 is usually so low that the removal of formaldehyde is not essential.

Schoedler, K., *Das Papier* 7, No. 7/8: 133–135 (1953); *cf. B.I.P.C.* 23: 585; *B.I.P.C.* 23: 754 (1953).

This gives essentially the same information as the previous reference, although more technical and economic data are included.

Jensen, W., Rinne, P., and Vainio, M., *Paper and Timber* 35, No. 4a: 135–138 (1953); *B.I.P.C.* 24: 56 (1953).

The fusel oil obtained in the production of alcohol from sulphite waste liquor was investigated. Jensen (*B.I.P.C.* 21: 353) previously observed a new fusel oil fraction boiling at 129°C./15 mm.; *n*-propyl guaiacol was shown to be the principal constituent. This fraction was only detected in one of the 15 samples of fusel oil from Finnish sulphite waste liquors which were investigated. This fraction has been examined further and found to contain 15 to 20% of its weight of eugenol. A third phenolic substance (so far not identified) may also be present. This is indicated by the paper chromatogram produced according to the method of Hossfeld (*B.I.P.C.* 21: 460). The presence of eugenol was also established by distillation in a spinning-band column after this fraction had been subjected to alkali fusion. Cis- and trans-isoeugenol were formed, which is further evidence of eugenol. Eugenol was finally isolated from this fraction by the method of Waterman and Priester (*Rec. trav. chim.* 48: 1278–1279 (1929)); the isolated eugenol was identified by its 3,5-dinitrobenzoate.

Perlman, D., Tempel, A. E., Jr., and Brown, W. E., *Ind. Eng. Chem.* 45, No. 9: 1944–1969 (1953); cf. *B.I.P.C.* 23: 96 (1952); *B.I.P.C.* 24: 100 (1953).

This general review of the recent literature of the fermentation process contains references on sulphite waste liquor and alcohol (p. 1946), yeast (p. 1949), enzymes, including amylase (pp. 1950–1951), and waste-disposal techniques (pp. 1961–1962) of possible interest to the pulp and paper industry.

Schoedler, K., *Wochbl. Papierfabrik.* 81: 470, 472, 474, 476 (1953); cf. *B.I.P.C.* 23: 585 (1953); *B.I.P.C.* 24: 231 (1953).

Statistical data are presented which show the enormous increase in the demand for solvents and plasticizers in industries which convert cellulose derivatives, such as the lacquer, rayon and staple fibre, and plastics industries. The large field of possible applications for acetone and butanol obtained from sulphite waste liquor for this purpose is pointed out. Cellulose glues and acetate lacquers are also extensively employed in the paper-converting industries.

FERTILIZERS

Grimmett, R. E. R., *Chem. & Ind.* No. 48: 1177 (1952); *B.I.P.C.* 23: 360 (1953).

A process similar to that developed by K. F. Hoy at Rukuhia Soil Research Station (New Zealand) is suggested whereby concentrated sulphite waste liquor might be used as the source of crude oxalic acid in the production of a new mixed-acid type of superphosphate fertilizer. As proposed, the process would digest concentrated sulphite waste liquor with concentrated nitric acid in the presence of a vanadium catalyst at 70 to 80°C. until most of the sugars and lignin is converted to oxalic acid and the sulphur compounds converted in part to sulphuric acid. The crude reaction product mixed with rock phosphate would then be matured to yield a final superphosphate of mixed sulphuric, nitric, and oxalic acid types.

FUNDAMENTAL INVESTIGATIONS

Lindgren, B. O., and Saeden, U., *Acta Chem. Scand.* 6: 963–965 (1952); *C.A.* 47: 861 (1953).

To determine if Z-type sulphonatable lignin groups (*C.A.* 46: 9840 (1952)) include structures of the type 3,4-OMe-(R″O)C_6H_3CHR′CH(OR)CH_2OH(R = H, R′ = SO_3H,R″ = alkyl group), ligninsulphonic acid was subjected to periodate oxidation, and ligninsulphonic acid and safrole glycol were tosylated and heated with NaI in Me_2CO. Calcium ligninsulphonate (2.5 grams) (10.7% OMe), 100 ml. acetate buffer (pH 3.5), and 25 ml. 0.2 *N* $NaIO_4$ were let stand 30 min. at room temperature, 20 ml. $Pb(NO_3)_2$ (12.5 grams per 100 ml.) was added, and the solution was evaporated *in vacuo;* the distillate gave a negative dimedone test for HCHO. Similar oxidation at pH 6 and 7 gave 0.01 mole HCHO/OMe. Ligninsulphonic acid (1 gram) (13.6% OMe), 5 grams tosyl chloride, and 20 ml. pyridine were let stand 92 hr., the precipitate was separated, and 0.4 gram was heated 17 hr. at 100° with 1.5 grams NaI and 10 ml. Me_2CO, H_2O was added, and the liberated iodine (0.05 mole/OMe) was determined. Saffrole glycol (3 grams), 5.85 grams tosyl chloride, and 15 ml. pyridine were let stand 24 hr. at room temperature, and evaporated *in vacuo,* $NaHCO_3$ solution was added, the mixture was extracted with $CHCl_3$, and the $CHCl_3$ solution was dried, filtered through Al_2O_3, and evaporated to give 2.85 grams safrole glycol ditoluenesulphonate, m. 135° (from C_6H_6), which was heated 12 hr. with NaI and Me_2CO at 100° to yield 95% toluenesulphonic acid and 90% iodine.

Fletcher, T. L., and Ritter, D. M., *J. Am. Chem. Soc.* 74: 3297-3300 (1952); *C.A.* 47: 861 (1953).

Bromination of ligninsulphonates with OC.CH_2.CH_2.CO.NBr gave good yields of derivatives having 1 aromatic Br per aromatic ring. A solution of the high-molecular weight ligninsulphonates obtained by dialyzing a calcium-base sulphite waste liquor from a commercial cook of western hemlock was passed through Ionex no 2 cation-exchange resin charged with H^+ ions and through the same type of resin charged with Li^+ ions to give the Li salt of ligninsulphonate. OC.CH_2.CH_2.CO.NBr (1 equivalent) and 465 mg. Me ester of methylated ligninsulphonic acid were dissolved in EtOH-free $CHCl_3$ to give an approximate 5% solution, 360 mg. OC.CH_2.CH_2.CO.NBr was added, the solution kept 24 hr. at 25°, the clear reaction mixture slowly poured with vigorous stirring into 250 ml. dry Et_2O and centrifuged to give a light-tan powdery product. Samples (250 to 300 mg.) of brominated ligninsulphonates were dissolved in a small amount of H_2O and made up to 5 ml. with 15 to 20% KOH, the mixture strongly acidified with HCl after 1 or 20 hr., and the precipitate centrifuged, washed repeatedly with 6 *N* HCl, and dried over P_2O_5 and NaOH at 1 mm. Similar dehalogenations were carried out with collidine and $PhNMe_2$ at 60 and 80°. The Br:C_9(OMe) ratios of the bromination product from Li salt, Li salt (fully methylated), and Me ester and 1, 2, 3, and 4 equivalent OC.CH_2.CH_2—CO.NBr before and after dehalogenation and the typical empirical formulas of the brominated ligninsulphonates are tabulated. Excess OC.CH_2.CH_2.CO.NBr and a rise in temperature for several hours seem also to remove side chain Br. An aromatically brominated ligninsulphonate (0.95 ± 0.05 Br/C_9) is best obtained by treating Li salt (fully methylated) in absolute EtOH with 2 equivalents OC.CH_2.CH_2.CO.NBr 15 to 20 hr. at 20 to 25° and then with 2 more equivalents OC.CH_2.CH_2.CO.NBr at 50 to 55°.

Matsui, T., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 53: 411–13 (1950); *C.A.* 47: 862 (1953).

In order to study the state of sugar in sulphite waste liquor, the reaction between glucose and sulphite has been studied at 130° by means of autoclaving. It has been found that they combined in the molecular ratio 1:2.

Matsui, T., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 53: 413–414 (1950); *C.A.* 47: 862 (1953).

Two compounds are isolated from the product of the reaction of glucose and sulphite by means of dialysis with fish skin and fractional precipitation with MeOH and ether: $C_6H_{10}O_5$.HSO_3Na, m. 180–185° (decomposition), $(\alpha)_D^{20}$ — 37.5, 4 HO groups; $C_6H_{10}O_5$.$(HSO_3Na)_2$, m. 197–200° (decomposition). The compounds are very hygroscopic and have no reducing power.

Matsui, T., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 53, 414–415 (1950); *C.A.* 47: 862 (1953).

Other possibilities of isolation of the compounds formed when glucose is reacted with sulphite have been studied.

Edhborg, A., Erdtman, H., and Leopold, B., *Acta. Chem. Scand.* 6: 450–451 (1952); cf. *C.A.* 46: 8854 (1952); *C.A.* 47: 2485 (1953).

A study was made of the alkaline desulphonation of spruce "Kullgren acid" (*C.A.* 39: 2196) S = 5.5%, Ba/S = 0.50, and S/OMe = 0.49) further sulphonated with Na_2SO_3 containing S^{35}. Active BaS^{35} was diluted with inactive BaS, the S^{--} precipitated as CdS, H_2S liberated by concentrated H_3PO_4, and converted to SO_2, which was absorbed in 2 *N* NaOH, the active sulphite solution taken to pH 1.5 with inactive SO_2, and the final solution used for the sulphonation of "Kullgren acid" 6 hr. at 135°. The active, sulphonated "Kullgren acid" (0.8 gram) in water was heated to 100°, 0.2 mol. NaOH solution added at 100° under N, the reaction stopped by the addition of concentrated HCl, SO_2 expelled by a N current, absorbed in dilute H_2O_2, the H_2SO_4 formed precipitated with $BaCl_2$, and the precipitate tested for S^{35} activity. The results showed that desulphonation involved one fast and one slow reaction, the former resulting in the liberation of approximately 30% of the total S. The specific activity of the liberated SO_2 decreased regularly with time, indicating that the S introduced in the second phase of sulphonation was most readily removed.

Mikawa, H., Sato, K., Takasaki, C., and Okada, H., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 54: 299–300 (1951); *C.A.* 47: 2981 (1953).

Wood powder is subjected to sulphite cooking and then to kraft cooking, or to the two processes in reverse order. The group which is sulphonated at pH 6 (Erdtman's A group) is not uniform and consists of two groups, X and Z. Sulphonation of X and Z at pH 6 is of first-order reaction. The X group combines also with S by digestion with H_2S water at pH 7. There seems to be another group Y which combines with H_2S under the same conditions but is not sulphonated at pH 6. The number of X group is 1 per molecular weight of lignin 1700–1800; Y, 7000–8000; Z, 1700–1800. The X group which takes part in both processes is supposed to be benzyl alcohol OH group (cf. Lindgren, *C.A.* 42: 6110 (1948); Enkvist and Moilanen, *C.A.* 43: 9438 (1949)).

Kleinert, T., and Wincor, W., *Das Papier* 6: 513–519 (1952); *C.A.* 47: 6655 (1953).

With minor modifications the tyrosine reagent developed

by Berk and Shroeder for determining tannins in water (cf. *C.A.* 36: 4642) was used successfully in estimating the total organic matter of beech and spruce waste sulphite liquors in dilutions up to 1 part in 50,000 by using visual photoelectric colorimeters. Glucose and free SO_2 do not influence the sensitivity of the test. H_2S (which may interfere) can be removed readily. In the estimation of lignin, the direct bromination of lignin-sulphonic acid was studied. For each C_9 group in lignin, approximately 4 Br_2 were consumed.

Mikawa, H., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 54: 762–764 (1951); *C.A.* 47: 8366 (1953).

The nature of the groups of lignin which combined with sulphur in sulphite and kraft cooking processes was studied. The behaviour of the groups X and Z observed in *Picea jezoensis* was also observed in red pine wood.

Sohn, A. W., *Holzforschung* 7: 1–8 (1953); *C.A.* 47: 9005 (1953).

By treating vanillin in CCl_4 with dry Cl, 5-chlorovanillin was formed which with KOH at 170 to 200° gave 3,4.5-$(HO)_2(MeO)C_6H_2CO_2H$. Vanillic acid, in $CHCl_3$ with Cl gave 5-chlorovanillic acid, m. 242°. 5-Chlorovanillic acid was also prepared, but less satisfactorily by treating vanillin in solution in the dark with ClO_2 (great care being taken to avoid explosions); viscous by-products were also formed. The removal of Cl from 5-chlorovanillic acid by KOH gave 3,4,5-$(HO)_2(MeO)C_6H_2CO_2H$. The introduction of the new OH groups was evidenced by the increase of per cent MeO, following methylation (despite the fact that these methylation products were nonhomogeneous). Attempts were made to chlorinate lignin, in the hope of attaining substitution on the aromatic nucleus. The following "lignins" were used (1) a calcium ligninsulphonate (from spruce), largely desulphurized by refluxing with 40% KOH followed by precipitation with acid; (2) a spruce lignin residue formed from a sodium ligninsulphonate; (3) a spruce wood-meal, pre-extracted with CH_2Cl_2 (thus retaining its native lignin). Each of the products (1), (2) and (3) in CCl_4 suspension was treated with Cl and (or) ClO_2. Although Cl was introduced into these lignins, relatively little entered the aromatic nucleus (as indicated by treatment with KOH, followed by methylation). The per cent new MeO groups was always low. Hence the "phenolic character" of lignin could not be enhanced. Sohn applied a similar technique (chlorination → KOH treatment) to quebracho extract and to spruce bark extract. Here, too, very little phenolic OH was obtained. The chlorination experiments do not indicate the nonexistence of an aromatic nucleus in lignin, inasmuch as natural tannins (known to contain this nucleus) also react sluggishly with Cl. Possible causes for this behavior are discussed.

Treiber, E., Kleinert, T., and Wincor, W., *Holzforschung* 6: 101–102 (1952); *C.A.* 47: 9009 (1953).

Ultraviolet adsorption measurements of beech and spruce sulphite waste liquors serve to supplement the earlier colorimetric and bromometric methods. Ultraviolet measurements permit the determination of beech and spruce waste sulphite liquors in dilutions of about 1 part in 10^5. The measurements, described in some detail, involve the use of a model DU Beckman quartz spectrophotometer, and readings were made at 278 mmu (at which beech and spruce sulphite waste liquors gave nearly identical ϵ values).

Senju, R., *Bull Chem. Soc. Japan* 25: 131–132 (1952); *C.A.* 47: 10222 (1953).

Ligninsulphonic acid is easily and rapidly determined in sulphite waste liquor by treating the sulphite waste liquor with polyglycolglucosamine and titrating the excess polyglycolglucosamine with polyvinyl alcohol sulphate. Thus, 5 ml. 1:120 sulphite waste liquor is treated with 5 ml. 0.01 *N* polyglycolglucosamine (calculated on the NH_2 group). The solution becomes turbid through the formation of a precipitate in the presence of excess polyglycolglucosamine. The mixture is titrated with 0.0025 *N* polyvinyl alcohol sulphate. At the equivalent point the colloidal solution becomes clear and the precipitate becomes flocculent. Very dilute solutions can be titrated with toluidine blue. From the weight of the precipitate and the fact that ligninsulphonic acid combines with polyglycolglucosamine in equivalent amounts the equivalent weight of ligninsulphonic acid can be calculated. Thus from a series of determinations on a sulphite cook at various times the equivalent weight of ligninsulphonic acid was 380.

Goldschmid, O., *J. Am. Chem. Soc.* 75: 3780–3783 (1953); cf. *C.A.* 43: 4461, 7680, 8890 (1949); *C.A.* 47: 11981 (1953).

The effects of sodium hydroxide and strong sulphuric acid on the ultraviolet absorption spectrum of lignin provide a method for separating the absorption due to phenylpropane units substituted with certain ionizable groups from that of the remaining lignin units and thereby provide information about the structure of lignin which cannot be obtained from its spectrum in neutral solutions. An indication of the spectrum of ionized groups is obtained by subtracting the absorption curve of the neutral solution from those of the alkaline and strong acid solutions, respectively. Difference curves for several lignin preparations reveal three absorption bands at approximately 250, 300, and 350 mmu. Spectra of phenol, guaiacol, veratrole, eugenol, conidendrin, *p*-hydroxybenzaldehyde, vanillin, veratraldehyde, and acetovanillone were determined under similar conditions for comparison. The height of the 298-mmu band of the difference curve provides a sensitive measure of the phenolic hydroxyl content of different lignin preparations. (Aulin-Erdtman, *Svensk Papperstidn.* 55: 745 (1952)); the height of the 350-mmu band provides a measure of α-carbonyl groups conjugated with free and etherified phenolic groups, respectively.

Mikawa, H., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 55: 294–296 (1952); cf. *C.A.* 47: 8366 (1953); *C.A.* 47: 12806 (1953).

Phloroglucinol was made to react with the product obtained by the repeated H_2S cooking of Japanese red pine. It was found that phloroglucinol combines with the Z group. Phloroglucinol was made to react with the product obtained by sulphite cooking of spruce. From the progress of reaction it was established that phloroglucinol combines with X as well as Z groups.

Lindgren, B. O., and Saeden, U., *Acta. Chem. Scand.* 6: 963–965 (1952); *B.I.P.C.* 23: 333 (1953).

When calcium ligninsulphonate is treated with sodium periodate at pH 3.5 no formaldehyde is formed; at pH 6 to 7 about 1 molecule of formaldehyde per 100 methoxyl groups is obtained. Treating a tosylated ligninsulphonic acid (9.08% sulphur content) with sodium iodide in acetone gives 1 molecule of iodine per 20 methoxyl groups. These results indicate that ligninsulphonic acid contains only a very small amount of terminal α-glycol groups.

Phillips, J. H., and Rubright, M. M., *Tappi* 36, No. 9: 392–401 (1953); cf. *B.I.P.C.* 22: 170 (1952); *B.I.P.C.* 24: 96 (1953).

A method for the determination of total water content, and by calculation, the total nonaqueous constituents in pulp mill residual liquors is described. This method, described in the reference, was reported at that time preferable to existing methods for analyzing magnesium bisulphite residual liquors and has now been found applicable for determining moisture in all types of residual pulping liquors. The method employs the two-solution modification of the well-known Karl Fischer titration and gives rapid and reproducible results with a greater accuracy than oven-drying methods. A determination can be completed in a few minutes in contrast to the time-consuming oven-drying methods.

Gilbert, E. E., and Jones, E. P., *Ind. Eng. Chem.* 45, No. 9: 2041–2064 (1953); *B.I.P.C.* 24: 107 (1953).

In a general review on this subject, a special section (pp. 2054–2055) is devoted to the sulphonation of lignin; 22 references in the lignin section covering the period 1950–52.

Neumann, F., *Das Papier* 7, No. 19/20: 388–391 (1953); *B.I.P.C.* 24: 185 (1953).

To determine the inorganic components present in sulphite waste liquor, the organic constituents must first be oxidized. The author recommends for this purpose the mixing of waste sulphite liquor with 30% hydrogen peroxide—about 10 ml. per gram of dry substance in waste sulphite liquor—at room temperature, whereupon the mixture is poured slowly into a Kjeldahl flask containing boiling sulphuric acid. Examples for determining the total nitrogen and potassium in waste sulphite liquor are given to illustrate the application of the method.

Neumann, F., *Das Papier* 7, No. 21/22: 425–426 (1953); cf. *B.I.P.C.* 23: 479 (1952); *B.I.P.C.* 24: 271 (1953).

In the previous communication it was mentioned that the presence of organic substances from sulphite waste liquor may interfere with the titration of calcium (and magnesium) in cooking acid and waste sulphite liquor with complexone and Eriochrome Black T indicator (or its mixtures). It has now been determined that this interference is caused by traces of heavy metals, copper in particular. A small amount (0.2%) of potassium cyanide added to the ammonia-ammonium chloride buffer solution (which will keep for at least 2 weeks) will render the interfering substances harmless.

Richtzenhain, H., and Alfredsson, B., *Act. Chem. Scand.* 7, No. 8: 1177–1185 (1953); *B.I.P.C.* 24: 281 (1953).

The hypochlorite consumption of lignin and of a series of lignin model compounds in alkaline solution at various temperatures has been determined. This consumption takes place in two steps: a very fast reaction and a much slower one. At 95°C. ligninsulphonic acid, alcohol lignin, native lignin and hydrochloric acid lignin consume quite rapidly about 8 moles of hypochlorite/lignin building stone. Thiolignin under the same conditions consumes 10 to 11 moles of hypochlorite. The ultraviolet absorption curves of the lignin preparations, taken after consumption of various amounts of hypochlorite, indicate that in the oxidized lignins aromatic ring systems have been degraded to a large extent. Methylation of the lignin retards the degradation and decreases the hypochlorite consumption. The oxidation of a large number of phenols with free and etherified hydroxyl groups shows that only those phenols which have free hydroxyl groups are readily decomposed. The rapid degradation of lignin preparations which contain only few free phenolic hydroxyl groups is explained by the liberation of originally etherified phenolic groups during the degradation.

Hunter, R. E., Tracy, J., Cutts, R., Young, R. E., Olin, J., and McCarthy, J. L., *Tappi* 36, No. 11: 493–497 (1953); cf. *B.I.P.C.* 21: 585; *B.I.P.C.* 24: 318 (1953).

Sulphite waste liquor density, viscosity, specific heat, and thermal conductivity values have been collected from the literature or determined experimentally at various temperatures and concentrations of dissolved solids. "Best" average values of these properties and of Prandtl numbers are proposed and are recommended for use in engineering design calculations. Examples are given showing applications of the data to design of fluid-flow and heat-transfer equipment.

ION EXCHANGE RESINS

Kin, Z., *Przeglad Papierniczy* 9: 113–116 (1953); *C.A.* 47: 8367 (1953).

Various methods of producing ion exchangers from waste sulphite or alkaline black liquors are reviewed. A new laboratory method repeated on a pilot-plant scale consists of treating sulphite waste liquor concentrated to 50% solids with 10% gaseous HCl and 6% HCHO (based on the solids), and heating at 140° for 24 hr. A hard cation-exchange resin of good exchange capacity is thus produced. Other satisfactory ion exchangers can be obtained also by condensing ligninsulphonic acid with phenol and HCHO.

Turvolgyi, B. L., Anyas-Weisz, L., and Graydon, W. F., *Can. J. Technol.* 31, Nos. 7 and 8: 168–171 (1953); *B.I.P.C.* 23: 920 (1953).

Mixed-bed, ion-exchange columns can be regenerated without separation by prior regeneration of the anion-exchange resin with sodium hydroxide solutions and subsequent regeneration of the cation-exchange resin with ligninsulphonic acid solutions. The large ligninsulphonate anions exchange very slowly. Data are reported for regeneration level and leakage of ligninsulphonic acids in the regeneration of a cation-exchange resin and for exchange of ligninsulphonic acids on an anion-exchange resin.

MAGNESIUM-BASE PROCESS

Darmstadt, W. J., and Richter, F. H., *Tappi* 36, No. 6: 171A–174A (1953); *C.A.* 47: 12806 (1953).

The economic aspects of the Tomlinson-Wilcoxson process for evaporating magnesium-base sulphite waste liquor and the recovery of heat and chemicals are discussed.

Wilcoxson, L. S., U. S. pat. 2,619,411 (Nov. 25, 1952); *B.I.P.C.* 23: 380 (1953).

A combustion furnace is described for the recovery of chemicals and heat from magnesium-base sulphite waste liquor. Provision is made for the continuous suspension burning of the waste liquor under controlled conditions of temperature and atmosphere for the recovery of chemicals in a dry state and for the absorption of heat in an associated vapour generator.

Cunningham, G. L., U. S. pat. 2,644,748 (July 7, 1953); *B.I.P.C.* 24: 82 (1953).

Sulphite pulping is carried out using a mixed calcium and magnesium base (dolomite). The waste liquor is neutralized with dolomite, and the calcium sulphite formed is separated and returned to the acid tower. The neutralized waste liquor is then rendered calcium-free by treatment with carbon dioxide (e.g., from cooking acid tower) and burnt dolomite rich in magnesium salts and removal of the precipitated calcium carbonate. The calcium-freed magnesium-base waste liquor is then evaporated and burned to yield sulphur dioxide for re-use with further dolomite and magnesia as a by-product.

MISCELLANEOUS USES

Genin, G., *Lait* 32: 454–459 (1952); *C.A.* 47: 4515 (1953).

The lignin obtained as a by-product of the paper industry can be used as a precipitant of proteins from skim milk. The use of lignin even in the crude form existing in sulphite liquors does not reduce the quality of the skim milk as a medium for certain microorganisms.

Kleinert, T., *Das Papier* 7: 82–87 (1953); *C.A.* 47: 7212 (1953).

CaO (20 grams per liter), when added to waste liquors or to the slops from EtOH manufacture, followed by heating at 140 to 150°, causes the formation of a precipitate containing 67% organic matter, 15 to 17% $CaSO_3$, and mineral components other than $CaSO_3$. Sulphur can be recovered from $CaSO_3$ either as SO_2 or SO_3. The thermoplastic properties of organic matter permit its use in plastics. The precipitate containing 67% organic matter dried and mixed with coal dust, can also be used as fuel. A very promising use of the precipitate containing 67% organic matter is in fertilizers and

soil conditioners. This precipitate, treated with NH_3 gives nitrogenous products which release NH_3 very slowly in the soil; this furnishes N over long time periods. This chemurgic behavior (duly protected by patents) is being studied further.

Gauvin, W., and Winkler, C. A., *Can. J. Technol.* 31: 114–119 (1953); *C.A.* 47: 7917 (1953).

Bindarine, a by-product of the sulphite pulp industry, has been used extensively as an addition agent in the electrodeposition of copper and other metals. Its action was studied in comparison with previous results obtained with gelatin. The bindarine contained 7.8 to 7.9% matter volatile at 100°, and 9.7 to 9.8% ash, and was very soluble in water, forming dark-brown colloidal solutions with a pH of 6.2 at 30% concentration. The charge on the colloidal particles was negative. The major portion of bindarine was calcium ligninsulphonate. Its presence in the electrolyte increased both the hardness of the deposited copper and the cathode polarization but to a smaller degree than do gelatin additions. This increase of the polarization did not continue beyond additions of 100 mg. per liter of bindarine. The acidity of the electrolyte had little effect; with increasing temperature polarization decreased. Probably the calcium ligninsulphonate was reduced at the cathode, and the reduction products, an insoluble mercaptan or a copper mercaptide, were adsorbed.

Booth, R. B., and Pickens, R. A., Can. pat. 489,950 (Jan. 27, 1953); *B.I.P.C.* 23: 529 (1953).

An improvement in the beneficiation by froth flotation of a metallic sulphite mineral (using a promoter such as a xanthate) consists in carrying out the separation in the presence of 0.01 to 0.5 lb. per ton of a surface-modifying agent for the mineral; this is a salt of a ligninsulphonate. This is the same as U. S. pat. 2,471,384 (May 24, 1949); cf. *B.I.P.C.* 19: 748–749.

Booth, R. B., and Pickens, R. A., Can. pat. 489,949 (Jan. 27, 1953); *B.I.P.C.* 23: 529 (1953).

The copper sulphite minerals content in the tailing from froth flotation can be reduced by forming an aqueous pulp of the ore, subjecting the pulp to flotation in the presence of a promoter (e.g., xanthate) and a surface-modifying agent (alkali or alkaline-earth metal ligninsulphonate). The resultant froth concentrate is recovered. This is the same as U. S. pat. 2,485,083 (Oct. 18, 1949); cf. *B.I.P.C.* 20: 215–216.

Hindall, A. L., Can. pat. 491,345 (March 17, 1953); *B.I.P.C.* 23: 695 (1953).

A negative plate paste for use in lead storage batteries includes an expander (92% by weight of the paste) for improving the cold discharge rate. A preferred form of the expander comprises 34 parts lignin-bearing material (e.g., red oak sawdust), 8 parts carbon black, 17 parts barium hydroxide, 7 parts sodium hydroxide, 34 parts lignone (sulphite waste liquor) and 1.2 parts nickel sulphate.

POLLUTION STUDIES

Amberg, H. R., *Paper Trade J.* 136, No. 9: 20–21, 31 (1953); *C.A.* 47: 8366 (1953).

Pollution by sulphite waste liquor has been successfully prevented by its utilization as a road binder, by its storage in lagoons, and by its disposal in submarine diffusion lines. These methods are discussed. Experimental work in the utilization of the liquor for soil conditioning and irrigation is appraised.

Schmidt, E., *Tappi* 36: 291–294 (1953); cf. *C.A.* 46: 10620 (1952); *C.A.* 47: 11728 (1953).

The question as to whether the oxygen demand in waste sulphite liquor can be measured by permanganate consumption is discussed.

Busch, A. W., and Sawyer, C. N., *Anal. Chem.* 24, No. 12: 1887–1891 (1952); *B.I.P.C.* 23: 311 (1953).

This investigation was made to determine whether the polarograph can be used as a labor-saving device for the measurement of dissolved oxygen in B.O.D. determinations. The method, when using an applied voltage of −1.6 v., was found to have an order of accuracy comparable with the standard Winkler technique. Residual current measurements were found unnecessary in the case of all the substrates and wastes studied at the concentration levels used in routine B.O.D. studies; rag-rope wastes and sulphite waste liquor were among the samples tested. The total elapsed time per determination averaged 75 sec., which is approximately a 50% saving in time over that needed in the Winkler test when large numbers of samples are involved. In instances where radioactive samples are under study, the method will greatly reduce radiation hazards through the elimination of sample overflow and the need for titration.

Rudolfs, W., and Hanlon, W. D., *Sewage Ind. Wastes* 24, No. 12: 1502–1508 (1952); cf. *B.I.P.C.* 22: 613; *B.I.P.C.* 23: 359 (1953).

A study was made for the purposes of (1) developing a method for expressing the effect of suspended matter on the color characteristics of industrial wastes; (2) using industrial waste light-absorption properties for calculating the concentration of industrial wastes in stream waters; and (3) investigating methods for projecting industrial waste-color characteristics to stream conditions. The wastes used in each part of the study, respectively, were: (1) clear dilute sulphite cooking liquor mixed with a Dicalite white filler solution; (2) yeast and beet canning waste; and (3) sulphite waste liquor. A method is presented for expressing the color characteristics of industrial waste suspended solids in terms of the visual hue and the degree of light absorption effected solely by the suspended matter. The principle of Beer's law was adapted to the light-absorption properties of polluted stream waters for the purpose of calculating the concentration of two or more contaminating wastes. The direct projection of industrial waste color characteristics to actual stream conditions is not feasible. However, these color characteristics may be extended to longer light absorption cells which are more suitable for stream-water standards.

Rothchild, H. A., *Tappi* 36, No. 1: 129–133A (1953); *B.I.P.C.* 23: 441 (1953).

The author discusses legal (current applicable laws) and technical aspects of stream pollution, as well as the public-relations phase of the problem.

Rudolfs, W., and Hanlon, W. D., *Sewage Ind. Wastes* 25, No. 1: 66–69 (1953); cf. *B.I.P.C.* 23: 359 (1953); *B.I.P.C.* 23: 441 (1953).

A study was made to determine the effect of sunlight and ultraviolet light on the color characteristics of various industrial wastes and to determine the effect of industrial wastes on the temperature rise of stream waters as a result of sunlight absorption. Sunlight and ultraviolet light (2537 A) are effective for reducing the color of rag cooking liquor, gum and yeast wastes. On the other hand, they increase the color of sulphite waste liquor. The presence of highly colored wastes in stream waters has little effect on the rate and extent of temperature rise resulting from sunlight absorption.

Kleinert T., and Wincor, W., *Das Papier* 6, No. 23/24: 513–519 (1952); *B.I.P.C.* 23: 546 (1953).

Methods which might be applicable to the detection and estimation of sulphite waste liquor in river waters were reviewed, and the so-called tyrosine reaction of Berk and Schroeder (cf. *Ind. Eng. Chem., Anal. Ed.* 14: 456–459 (1942)) was re-examined and found to be especially suitable. With minor modifications of this method, the total organic matter

of both hardwood (beech) and softwood (spruce) sulphite waste liquors could be estimated reliably in dilutions up to about 1:50,000 using visual photoelectric colorimeters. Sugar (glucose) and free sulphur dioxide do not influence the sensitivity of the test. Hydrogen sulphide may interfere, if present, but can easily be removed by weak acidification with phosphoric acid and brief heating before use of the tyrosine reagent. For the direct determination of lignin, the direct bromination of ligninsulphonic acid was studied further, and the bromine consumption for both beech- and sprucewood lignin substances were found to be about similar at a level of approximately eight atoms of bromine for each phenylpropane group.

Bruneau, L., *Svensk Papperstidn.* 56, No. 6: 204–213 (1953); *B.I.P.C.* 23: 669 (1953).

At the instigation of the department of fisheries, three series of investigations on the extent of water pollution in the vicinity of pulp mills in four different areas on the coast of the Swedish province Angermanland were carried out in July and September of 1949 and in August of 1952. The principal purpose of the study was the determination of the distribution and flow of the pollution which could still be detected by ordinary hydrographic methods at any distance from the mill. Local conditions and the influence of sea-water currents are described in detail. Profiles comparing the conditions during 1949 and 1952 are included. In the surroundings of the mills at Köpmanholmen and Husum only a local pollution could be found, which was naturally strongest in the immediate vicinity of the mills and decreased rapidly toward the open sea water. Along the lower Angerman River, pollution was found to be surprisingly low, particularly in view of the large number of mills located on this river. In the bay of Ornsköldsvik the situation had been quite serious in 1949; the surface water was strongly polluted and almost completely devoid of oxygen, particularly in the Fall study. The 1952 pattern showed much better oxygen values in the surface water and a generally improved picture. This might have been a coincidence; however, other observations, for instance, improved salmon runs up the river, indicate that the improvement is real and the result of the waste liquor evaporation since then practiced in the mills of the Mooch Domsjö group. Based on the experiences gained in these investigations, similar studies are planned for the Skagerak in the summer of 1953 as a joint project of the fishery department and the pollution committee of the Swedish pulp mills.

National Council for Stream Improvement. *Tappi* 36, No. 4: 163–166A (1953); cf. *B.I.P.C.* 21: 583–584; *B.I.P.C.* 23: 670 (1953).

The research and development activities of the Council during 1952 are reviewed, including Oregon State College and Bates College (sulphite waste liquor), Louisiana State University (kraft mill wastes), Virginia Polytechnic Institute (semichemical wastes), Rutgers University (white water and rag, rope and jute wastes), University of Michigan (stream analysis), Kalamazoo College (deinking mill waste), Purdue University (strawboard wastes), and the Institute of Paper Chemistry and Oregon State College (aquatic biology).

Rudolfs, W., and Hanlon, W. D., *Sewage Ind. Wastes* 25, No. 3: 314–324 (March, 1953); cf. *B.I.P.C.* 23: 441 (1953); *B.I.P.C.* 23: 670 (1953).

Studies to determine the effect of chlorination on the color and B.O.D. characteristics of industrial wastes (including rag cooking waste, gum wastes, sulphite waste liquor, and yeast wastes) and the influence of related factors on color reduction, show that the effectiveness of chlorination is dependent upon the pH of the waste solution, the form of chlorine, the contact time, and the loss of chlorine to the atmosphere. As a rule, color reduction by superchlorination is relatively low.

Rudolfs, W., and Hanlon, W. D., *Sewage Ind. Wastes* 25, No. 4: 484–489 (1953); *B.I.P.C.* 23: 671 (1953).

Laboratory studies were made to determine the effects of biological treatment and activated carbon on the color removal of industrial wastes (rag, rope, and jute cooking liquor, board mill white water, waste sulphite liquor, gum, and yeast wastes). The following conclusions can be drawn from the results: The effect of biological treatment on the color characteristics varies with the type of waste and treatment. Activated carbon is effective for reducing the color of rag cooking liquor, gum, and yeast wastes, but not of sulphite waste liquor.

Van Horn, W. M., *Paper Ind.* 34, No. 12: 1456–1458 (1953); *B.I.P.C.* 23: 673 (1953).

The author describes recent developments in the successful disposal of sulphite waste liquor; only those are considered which have been proved either by full-scale commercial or at least pilot-plant operation, including evaporation and burning either with or without a change from calcium as a base; specialized fermentation, such as yeast production; use of the liquor in building and stabilizing dirt, sand, or gravel roads; further development in the utilization of lignin, for instance, in chemical or pharmaceutical products; and exploitation of the dilution method. The most suitable development for any one mill or condition can be determined only after a thorough assessment of the conditions in that mill.

Treiber, E., Kleinert, T., and Wincor, W., *Holzforschung* 6, No. 4; 101–102 (1952); *B.I.P.C.* 23: 909 (1953).

Ultraviolet absorption measurements of beech and spruce sulphite waste liquors are described; they serve to supplement earlier colorimetric and bromometric methods (cf. *B.I.P.C.* 23: 546–547). Ultraviolet measurements permit the determination of beech and spruce sulphite waste liquors in dilutions of 1 part in 10^5. The measurements, described in some detail, involve the use of a model DU Beckman quartz spectrophotometer; readings were made at 278 mmu at which beech and spruce sulphite waste liquors gave nearly identical values.

Murdock, H. R., *Ind. Eng. Chem.* 45, No. 11: 102A, 104A, 106A (1953); *B.I.P.C.* 24: 316 (1953).

Since 1935 sulphite capacity has remained practically constant, whereas the sulphate industry has shown tremendous growth; stream pollution connected with the sulphite process is given as one of the significant reasons for the nonexpansion of the former. The problem of dealing with the sulphite waste liquor and some of the successful solutions to date are discussed. The author predicts further developments along these lines stimulated by process competition and possible economies.

PRECIPITATION OF ORGANIC AND INORGANIC COMPOUNDS

Povazske Celulozky a Papierne, narodny podnik. Brit. pat. 691,911 (May 27, 1953); *C.A.* 47: 10852 (1953).

Sulphite waste liquor is treated with NH_3 under a pressure of at least 10 atm. at a temperature above 100° for 1 to 4 hr.; the concentration of NH_3 in sulphite waste liquor is from 5 to 15%. After the excess of NH_3 is distilled off and $CaSO_3$ separated, sulphite waste liquor is acidified with an inorganic acid to liberate sulphur dioxide and precipitate the lignin substance, which is suitable for further chemical conversion (vanillin) or for combustion purposes. The liberated sulphur dioxide is reused in the preparation of fresh cooking liquor. Desugared sulphite waste liquor or the residual liquid from the distillation of alcohol from sulphite waste liquor can be also used.

Celulozove a papiernicke zavody na slovensku. Austrian pat. 176,112 (Sept. 25, 1953); *C.A.* 47: 11736 (1953).

Sulphite waste liquor from which the sugar content has been

removed by fermentation is treated with NH_3 with pressure and at temperatures greater than 100° for 2 to 5 hr. until an NH_3 concentration of 2 to 15% is reached. The excess of NH_3 is then evaporated, $CaSO_3$ is removed, the filtrate is acidified to pH 5 to 6 with mineral acids, and the precipitated organic matter is filtered off and worked up for plastics, vanillin, etc.

Benton, A., and Carlander, R., Swed. pat. 140,463 (May 19, 1953); *C.A.* 47: 11736 (1953).

The SO_2 content of cellulose sulphite waste liquor is reduced to about 8 grams per liter by application of reduced pressure. NH_3 or NaOH is added until the pH is 8, and the precipitated calcium sulphite is removed. In a modification, the liquor is cooled to 50°C. to give a high SO_2 content, and is then diluted with liquor which has been degasified in the usual way.

Ehrensperger, H., Can. pat. 492,870 (May 12, 1953); *B.I.P.C.* 23: 856 (1953).

Addition products of a ligneous nature, which are useful as plastics, are formed and precipitated by the subjection of sulphite waste liquor to the action of reagents selected from the group consisting of quaternary ammonium bases and salts. This is the same as U. S. pat. 2,594,302 (April 29, 1952); *cf. B.I.P.C.* 22: 798–799.

RE-USE OF SULPHITE WASTE LIQUOR

Westlin, E. A., Swed. pat. 135,990 (June 3, 1952); *C.A.* 47: 319 (1953).

Cellulosic material is first treated with an acid liquor containing SO_2 and bisulphite ions equivalent to 49 to 90 grams of total SO_2 per liter at a temperature of 80 to 125°, preferably 95 to 115°, to convert the lignin to a soluble form by sulphonation. The total SO_2 content is then reduced to 2 to 10 grams per liter, e.g. by degassing, to dissolve the hemicellulose and sulphonated lignin which is formed. The latter step is preferably carried out at higher temperatures, such as 145 to 165°. The acid liquor may contain sulphite waste liquor and 6 to 10% by weight of solid matter derived from the waste liquor. The acid liquor has preferably a high ratio of bisulphite to free SO_2 and may contain, e.g., 55 grams per liter total SO_2 and 11 to 12 grams per liter of CaO.

Hagglund, E., *Das Papier* 7: 41–46 (1953); cf. *C.A.* 45: 5405 (1951); *C.A.* 47: 6655 (1953).

Sulphite cooking with recycling of waste liquor is reviewed.

Hartler, N., and Samuelson, O., *Svensk Papperstidn.* 55, No. 22: 851–862 (1952); *B.I.P.C.* 23: 315 (1953).

The present work deals with experiments concerning the hydrolytic action of sulphuric acid, high molecular ligninsulphonic acid, and sulphite waste liquor upon free cellulose fibers (i.e., not in the form of wood chips); cotton fibers and sulphite pulp were employed. At acid concentrations which give the same rate of inversion of cane sugar, high molecular ligninsulphonic acid results in a considerably slower degradation of the cellulose fibers than sulphuric acid. The experiments indicate that the cellulose regions which are accessible to the low-molecular acid cannot be penetrated by the high-molecular one. Hence, high molecular ligninsulphonic acid attacks chiefly the surface of the fiber, whereas sulphuric acid has the ability to react also with certain inner portions of the structure. During the sulphite cook, the waste liquor consists of a mixture of high and low-molecular acids; despite this fact, the degradation follows, on the whole, the trends of a low-molecular acid. This can be explained by the Donnan effect. However, as far as the carboxyl content of the hydrolyzed sample is concerned, certain differences have been established between sulphuric acid and sulphite waste liquor; the carboxyl number was somewhat higher in the experiments with sulphite waste liquor than in those with sulphuric acid. The results presented in the experimental part of this study show that considerable differences exist in the behavior of cotton fibers and sulphite pulp during the acid hydrolysis. Previous authors have established that these differences result at least partly from differences in the fiber structure and that the less ordered areas are preferentially attacked during the reaction. The authors compare the rate of hydrolysis (drop in D.P.), yield of hydrolyzed cellulose, cold and hot alkali solubility, yield of cold and hot alkali-resistant cellulose, and carboxyl number of cotton fibers and sulphite pulp as obtained under the conditions of their somewhat different experiments. They established differences in the behavior of cotton fibers and sulphite pulp which have hitherto not been recorded. Particular reference is made to the viscosity (D.P.) of the cellulose as a function of the time of reaction. In agreement with previous investigators, the rate of degradation (drop in D.P.) of cotton fibers was found to be considerably higher in the first part of the hydrolysis. The differences are so great that the curves (D.P. versus time) cross each other. However, on further hydrolysis, they cross each other a second time; during this latter part, the D.P. drops more rapidly with sulphite pulp than with cotton fibers.

Kyrklund, G., U. S. pat. 2,639,986 (May 26, 1953); *B.I.P.C.* 23: 856 (1953).

A two-stage sulphite pulping procedure is outlined, in which the waste liquor withdrawn from one cook is fortified with a suitable base and sulphur dioxide and used for the precook stage in the next cook. Upon withdrawal from the digester, the waste liquor contains approximately twice the amount of organic solids found in the waste liquor from a one-stage cook. By a careful utilization of the wash water in the acid make-up, it is claimed that the final wash water to the sewer will contain only minute amounts of organic material, thereby resulting in more complete recovery of organic substances and reduction in stream pollution.

REVIEW ARTICLES

Annett, S. R. P., and Stobo, W. E., *Paper Ind.* 34: 1109–1111 (1952); *C.A.* 47: 1385 (1953).

The production, marketing, and uses of Lignosol in agriculture, mining, adhesives, and dispersants are outlined.

Van Horn, W. M., *Paper Ind.* 34: 1456–1458 (1953); *C.A.* 47: 4602 (1953).

A résumé of using or disposing of the waste liquors, together with changes in sulphite procedures. The uses of waste liquors in road treatment, in the production of yeasts, and in the manufacture of pharmaceuticals from lignin derivatives are outlined, and the disposal of waste liquors (by burning or dilution) is outlined.

Marshall, H. B., *Pulp Paper Mag. Can.* 54, No. 5: 112–115 (1953); *C.A.* 47: 9610 (1953).

A review of present and potential uses for sulphite waste liquor in Canada.

Anon., *Chem. Week* 72, No. 6: 42–44 (1953); *Chem. Eng.* 60, No. 4: 122, 124–125 (1953); *Paper Mill News* 76, No. 18: 15–16 (1953); *B.I.P.C.* 23: 509, 672, 829 (1953).

The conversion products obtained from calcium ligninsulphonate by Marathon's Chemical Division and their various applications are described briefly, including vanillin; dispersants in oil-drilling muds, carbon black for the compounding of synthetic rubber tires, dyes, insecticides, metal cleaners, etc.; water-treatment compounds; expanders in batteries; tanning agents; stabilizers for wax or asphalt emulsions; flotation processes; and several others. The Chemical Division is now buying the waste liquor from another mill, because the demand for its products is outstripping the raw material.

Gabrielson, C. O., *Paper and Timber* (Finland) 35, No. 3: 73–78 (1953); *B.I.P.C.* 23: 629 (1953).

The author discusses the manufacture of organic chemicals from by-products of the pulp industry in Sweden, including sulphite alcohol, crude tall oil, sulphate turpentine, cymene, and methanol; some cellulose is also used for the manufacture of chemicals. The value of the yearly production of organic chemicals derived from the pulp industry is about 50 million Swedish crowns or a little less than one third of the total Swedish production of synthetic organic chemicals. Following a brief survey of the historical development of this industry, the principal products and their production rates are discussed. The increasing competition from other European producers has forced the industry to a considerable expansion during the last three years, so that the production cost per ton produced could be lowered. The industry is now in a better position to meet the foreign competition. In conclusion, the Swedish ethyl alcohol market and the competitive position for organic chemicals made from ethyl alcohol are discussed.

Sulphite Pulp Manufacturers' Research League, Inc., *Tappi* 36, No. 5: 92A, 94A (1953); *B.I.P.C.* 23: 754 (1953).

The present status of the League's research program is reviewed, including whole-liquor research (roadbinder, evaporation, burning, briquetting, and miscellaneous, such as agricultural uses, adhesives, and dispersants), sugar-fraction research, and lignin-fraction research.

Lewis, H. F., Proc. Fourth Ann. Ind. Waste Conf., State Coll. of Washington, 35–42 (1952); *B.I.P.C.* 23: 920 (1953).

A brief history and a review of the development of the Sulphite Pulp Manufacturers' Research League Incorporated, is given. The accomplishments from 1939–52, including whole-liquor studies (evaporation and burning, briquetting, road-binder studies, etc.) and studies on fractions (sugar, lignin, and recovery of pulping chemicals) are discussed.

Hearon, W. M., *Tappi* 36, No. 9: 14A, 16A, 18A, 20A (1953); *B.I.P.C.* 24: 143 (1953).

The sulphite pulping process uses a mixture of metallic bisulphite (usually calcium) and sulphurous acid to dissolve the lignin. The lignin, as ligninsulphonic acid, sugars, concurrently dissolved, and inorganics are removed from the pulp and form the main constituents of the sulphite waste liquor. About 25 million tons of this liquid with 10% solids are annually available for utilization. The liquor represents potentially a huge source of organic chemicals. This has led to a vast published literature on the use of sulphite waste liquor as such or as a starting material for other preparations, but very little of the literature results have reached commercial practice. In the past, all the waste liquor has been discharged into waterways. With the growing stress on stream improvement, more effort and of a higher scientific caliber has been exerted to utilize the waste liquor profitably. However, as no use has developed of sufficient magnitude to require nearly all the liquor, most sulphite pulp producers have resorted to other means to alleviate the stream pollution situation. These measures are not discussed. Several paper companies are, however, partially utilizing their liquor by profitable sale. The binding properties of the liquor have been of value in its use for surfacing dirt roads, and for making gummed tapes, briquets, and foundry cores. The dispersing action of the ligninsulphonic acids allows their use in making cement, in gypsum wallboard, in the dyeing of fabrics, as a treatment for boiler water, as a dispersing agent for carbon black in rubber, for controlling the viscosity of oil-well drilling muds, and as a dispersing agent for insecticide-remittable powders. The waste liquor also finds use as a chemical raw material, including vanillin and alcohol. A large pilot plant employs the liquor as a food for producing torula yeast. Intensive research on sulphite waste liquor and on lignin continues in many industrial and scholastic laboratories. Unless some major use for sulphite waste liquor as such is found, any future large-scale utilization of it will have to depend on its conversion to bulk organic chemicals.

Marshall, H. B., and Neate, J. M., *Pulp Paper Mag. Can.* 54, No. 7: 125–135, No. 9: 113–126 (1953); cf. *B.I.P.C.* 22: 775 (1952); *B.I.P.C.* 24: 144 (1953).

An annotated bibliography of literature published during 1952 is presented under the subject headings: ammonia-base process, base-exchange materials, binding materials, chemicals, emulsifying and dispersing agents, fermentation, fertilizers, and hydrogenation in the first part, and initial treatment of sulphite waste liquor, laboratory investigations, magnesium-base process, miscellaneous uses, pollution studies, tanning materials, and review articles in the second.

SODIUM-BASE PROCESS

Thomsen, A. M., U. S. pat. 2,618,610 (Nov. 18, 1952); *C.A.* 47: 2486 (1953).

NaOH and Na_2SO_3 are regenerated from the waste cooking liquor by recycling a portion of the waste cooking liquor as an ingredient of the new cooking liquor; saturating the remainder with CO_2 and separating the organic compounds thus rendered insoluble; acidifying the residual liquor with SO_2; separating the organic compounds and recycling a portion of the acid liquor as an ingredient of the new cooking liquor; causticizing the rest of the acid liquor with CaO; separating and reserving for future use the $CaSO_3$ and recycling the caustic liquor as an ingredient of the new cooking liquor; decomposing the rest of the SO_2-treated liquor with H_2SO_4; separating SO_2 and the liberated organic compounds; mixing the remaining solution with recycled $CaSO_4$, heating in an oxidizing atmosphere until all organic material is destroyed, and leaching with water to separate $CaSO_4$, thus leaving Na_2SO_4 in the solution; mixing the solution with the previously reserved $CaSO_3$ and acidifying with SO_2; and separating $CaSO_4$ and recycling the Na_2SO_3 solution as an ingredient of the new cooking liquor. The sizes of the various recycled fractions are adjusted to produce the new cooking liquor identical in composition to the original cooking liquor.

Aries, R. S., and Pollack, A., *Tappi* 35, No. 12: 142A–146A (1952); *C.A.* 47: 10847 (1953).

In the Sulfox process, sodium is substituted for calcium in the sulphite cook. The waste liquor is evaporated and burned, yielding a smelt of Na_2S and Na_2CO_3. The smelt is dissolved, and the Na_2S is air-oxidized to give Na_2SO_3. The Na_2SO_3 and Na_2CO_3 are combined with recovered SO_2 to give make-up acid for cooking.

Gray, K. R., and Crosby, H. L., U. S. pat. 2,656,245 (Oct. 20, 1953); *B.I.P.C.* 24: 343 (1953).

This is very similar to U. S. pat. 2,656,244 (Oct. 20, 1953; cf. abstract below). In addition the use of carbon dioxide under pressure or carbonic acid for the regeneration of the resin to produce carbonate or bicarbonate is claimed.

Gray, K. R., and Crosby, H. L., U. S. pat. 2,656,249 (Oct. 20, 1953); *B.I.P.C.* 24: 343 (1953).

The production of pure sodium bisulphite solution from natural brines or crude chemicals is claimed by a process of adsorbing the sodium ions on a cationic resin, then regenerating the resin with sulphurous acid; a sodium bisulphite solution results from this regeneration process.

Gray, K. R., and Crosby, H. L., U. S. pat. 2,656,244 (Oct. 20, 1953); *B.I.P.C.* 24: 344 (1953).

A recovery process for waste soda-base sulphite and bisulphite liquors involves evaporating and burning the liquor under reducing conditions in a furnace similar to that employed in the kraft industry. The smelt derived from the burning is

dissolved to form "green liquor," and the liquor is treated with a cationic resin to adsorb the sodium ions; the effluent contains a substantial portion of weakly acidic components in volatile form, e.g. hydrogen sulphide. Regeneration of the resin is accomplished with sulphurous acid; the effluent from this process contains sodium bisulphite and free sulphurous acid which may be used as produced for cooking acid or be fortified with additional sulphur dioxide.

TANNING MATERIALS

Hachihama, Y., and Kyogoku, Y., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 54: 197–198 (1951); *C.A.* 47: 1959 (1953).

Methods have been studied for determination of ligninsulphonic acid, the tanning agent from sulphite waste liquor, as well as for the mixture of the tanning agent and tannin. The amount of ligninsulphonic acid determined as tannin by the American Leather Chemists Association method corresponds roughly to 70% of the total ligninsulphonic acid found by determining methoxyl groups. In the ALCA method the amount of absorbed ligninsulphonic acid determined as the difference of the total and unabsorbed ligninsulphonic acid agrees well with the amount of tanning constituent. A method of analysis is proposed for the mixture of tanning agent and natural tannin by the combined use of the ALCA method and the determination of ligninsulphonic acid by means of the methoxyl group determination.

Gaidarov, L. P., *Legkaya Prom.* 9, No. 6: 16–18 (1949); *C.A.* 47: 1960 (1953).

The interaction of chrome and sulphite waste liquors in combination tanning was studied. Mixtures were prepared from equal volumes of liquors. Experimental and calculated specific gravity were in agreement. The color of mixtures in reflected light varied with concentration of one or other material. All mixtures were turbid and gave a distinct Tyndall cone. Precipitates were also observed. Precipitates consisting entirely of calcium sulphate showed no trace of chrome. It is assumed that either the SO_4^{--} ions of the outer sphere enter into reaction or there is initially the expulsion of SO_4^{--} ions from the inner sphere by the stronger complex formers, such as $HCOO^-$, and then all the SO_4^{--} ions react with the ions of the alkali earth metals. Special investigation is necessary to determine which of these is true.

Gaidarov, L. P., *Legkaya Prom.* 9, No. 7: 18–21 (1949); *C.A.* 47: 2525 (1953).

Electrophoretic observations indicate that in mixed chrome and ligninsulphonate liquors the chrome complex in general is not negatively charged; this also confirms the absence of substantial changes in its inner sphere. Electrolysis of the mixed liquors showed an independent movement to the electrodes of the positive charged chrome complexes and ligninsulphonate anions, indicating absence of coordinative bonds between the ligninsulphonate tannins and the chrome complexes. Spectrophotometric observations confirm that addition of ligninsulphonate causes no substantial changes. The absorption curves and magnitude of optical density of mixed liquors are additive.

Hachihama, Y., and Kyogoku, Y., *J. Chem. Soc. Japan, Ind. Chem. Sect.* 54: 227–228 (1951); cf. *C.A.* 47: 1959 (1953); *C.A.* 47: 3016 (1953).

Pelts, limed as well as delimed, and hide powder were tanned with liquors consisting of sulphite waste liquor and natural tannin in various proportions, and the changes of the composition of the liquors with time were studied. The natural tannin was absorbed to a greater extent than lignin-sulphonic acid.

Muller, O. A., *Das Leder* 3: 174–177 (1952); cf. *C.A.* 46: 4261 (1952); 47: 3595 (1953).

Comparative determinations of tan value and combining value were made by the previously described method on four vegetable extracts, three syntans, and three sulphite waste liquor cellulose extracts. Vegetable extracts were tested at their natural pH values. Other extracts and the wash water for determining combining value were adjusted to pH 3.5. The hide material was used in the form of powder, shavings, and pieces. Tanning times were 3, 10, 21, and 42 days. Hide material tanned with cellulose extract was washed one 15 to 20-hour period, other tannages for two periods. Tan value was highest with vegetable extracts and lowest with cellulose extracts. Powder gave the highest and pieces the lowest values of tan value in all tests, including the 42-day tannage, indicating that tanning-active collagen groups are set free during grinding of the skin to powder. For vegetable extracts combining values were higher with pieces than with powder, but the reverse was true for the other materials. Increasing the amount of tannin in the tan liquor from 200 to 300% (dry hide basis) increased tan value and combining value appreciably for vegetable extracts and moderately for the other materials. Tanning was nearly complete with only 100% of the cellulose extract tannin. Maximum values with hide pieces for vegetable extracts, syntans, and cellulose extracts were as follows: tan value, 100–110, 60–80, and 50; combining value, 80–90, 60–70, and 50, respectively. The matter lost during washing for determination of combining value was greater with hide powder than with pieces. With vegetable extracts the washing loss decreased only slightly as time of tanning increased. The washing loss with cellulose extract was extremely small.

Badische Anilin- & Soda-Fabrik, Fr. pat. 879,113 (Feb. 15, 1943); *C.A.* 47: 4608 (1953).

Raw or desugared sulphite waste liquor is treated, while still hot, with alkali, and acidified; the organic substances are separated by addition of neutral salts or more acid. In an example, 30 liters of sulphite waste liquor at 8.2° Bé. is mixed with 1 liter of NaOH solution at 38° Bé. for 2 hr. at about 100°. The liquor is acidified with 50% H_2SO_4, and $CaSO_4$ is separated by sedimentation. Na_2SO_4 (5 kg.) is then mixed in and the organic substances, which float on the surface, are removed. The organic substance (2.77 kg.) is obtained at 59.8% concentration. The product contains 9.6% ash and 40.2% tanning material, and is water-soluble.

Zellstofffabrik Waldhof, Ger. pat. 863,983 (Jan. 22, 1953); *C.A.* 47: 6142 (1953).

The known process of preparing sulphite waste liquor extracts by neutralization, evaporation, and precipitation with suitable acids to remove the calcium ions is improved by treating waste sulphite liquor before the evaporation with liquid or gaseous ammonia until the neutralization point is reached or slightly exceeded, preferably at elevated temperature. The quantity of the precipitating acid should be selected so as to effect a complete precipitation of the present calcium ions as insoluble salt and to set free the ligninsulphonic acid. Thus, gaseous or liquid ammonia is added to 1 cu. m. of 60° Bé. unfermented sulphite waste liquor until sulphite waste liquor shows no acid reaction against litmus. The liquor is evaporated up to 30° Bé. and then triturated with a mixture of equivalent quantities of $(CO_2H)_2$ and H_2SO_4 diluted with the same amount of water until the calcium compounds are practically completely precipitated. The precipitate is removed, and the solution of pure ligninsulphonic acid can be used for tanning purposes; it contains (calculated on dry substances) about 74% tanning matters, 2.9% ash, and 4.5% inorganic salts.

Brihta, I., Glavas, A., and Dugosevic, J., *Kemija u Industriji* (Zagreb) 2: 145 (1953); *C.A.* 47: 9039 (1953).

A good tanning effect was achieved by impregnating hides with furfuryl alcohol, which was subsequently subjected to a condensation process by immersing the impregnated hides in a solution of a mineral or a stronger organic acid such as lignin-

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sulphonic acid. According to the strength of the condensing acid solution, softer and lighter, or harder and darker leathers were obtained. No deterioration of the leather was observed within 1 year after tanning. A tanning effect was also produced by merely exposing hides impregnated with furfuryl alcohol to air.

W. H. S., *Ind. Eng. Chem.* 45, No. 3: 15A, 17A (1953); *B.I.P.C.* 23: 587 (1953).

Reference is made to efforts for finding additional vegetable tannin sources in the United States, including experiments with canaigre, wattle, hemlock, mangrove, scrub oak, etc.; modified lignin extracts and synthetic tanning agents are also listed.

STODDARD, W. B., JR., U. S. pat. 2,640,052 (May 26, 1953); *B.I.P.C.* 23: 857 (1953).

Waste liquor from the soda, kraft, or alkaline sulphite processes, either in the dilute or concentrated form (preferably the latter), is acidified (maximum yield at pH 4) to precipitate the alkali lignin in a form known as "sodium lignate." The sodium lignate is separated from the liquor, redispersed in water, then chlorinated until the lignin product analyzes 15 to 30% chemically combined chlorine on the weight of the dry product. Undesirable salts may be removed by washing at a low pH at this point. This product is solubilized by raising the pH to 8 or 8.5 with the addition of an alkali-metal hydroxide, carbonate, or bicarbonate. The final pH is adjusted as desired for the tanning operation. These tanning agents may be used alone or in combination with commercial vegetable tanning agents (e.g., quebracho, wattle, sulphite spruce) to produce leathers, light brown in color, resistant to tearing, cracking, shrinking, and mold growth.

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Eighth Alkaline Pulping Conference, Dinkler-Tutwiler Hotel, Birmingham, Ala., October 6–8, 1954.

Fourth Testing Conference, Dayton-Biltmore Hotel, Dayton, Ohio, October 6–8, 1954.

Ninth Engineering Conference, Benjamin Franklin Hotel, Philadelphia, Pa., October 18–21, 1954.

Fibrous Agricultural Residues Conference, Northern Regional Research Laboratory, Peoria, Ill., November 8–9, 1954.

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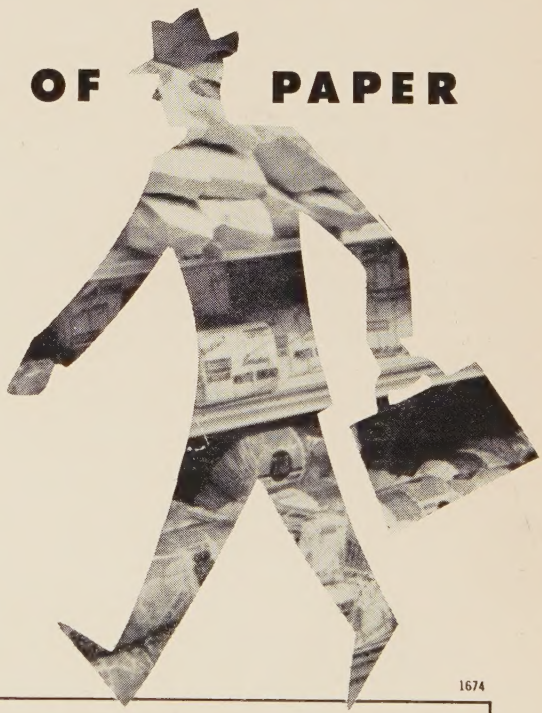

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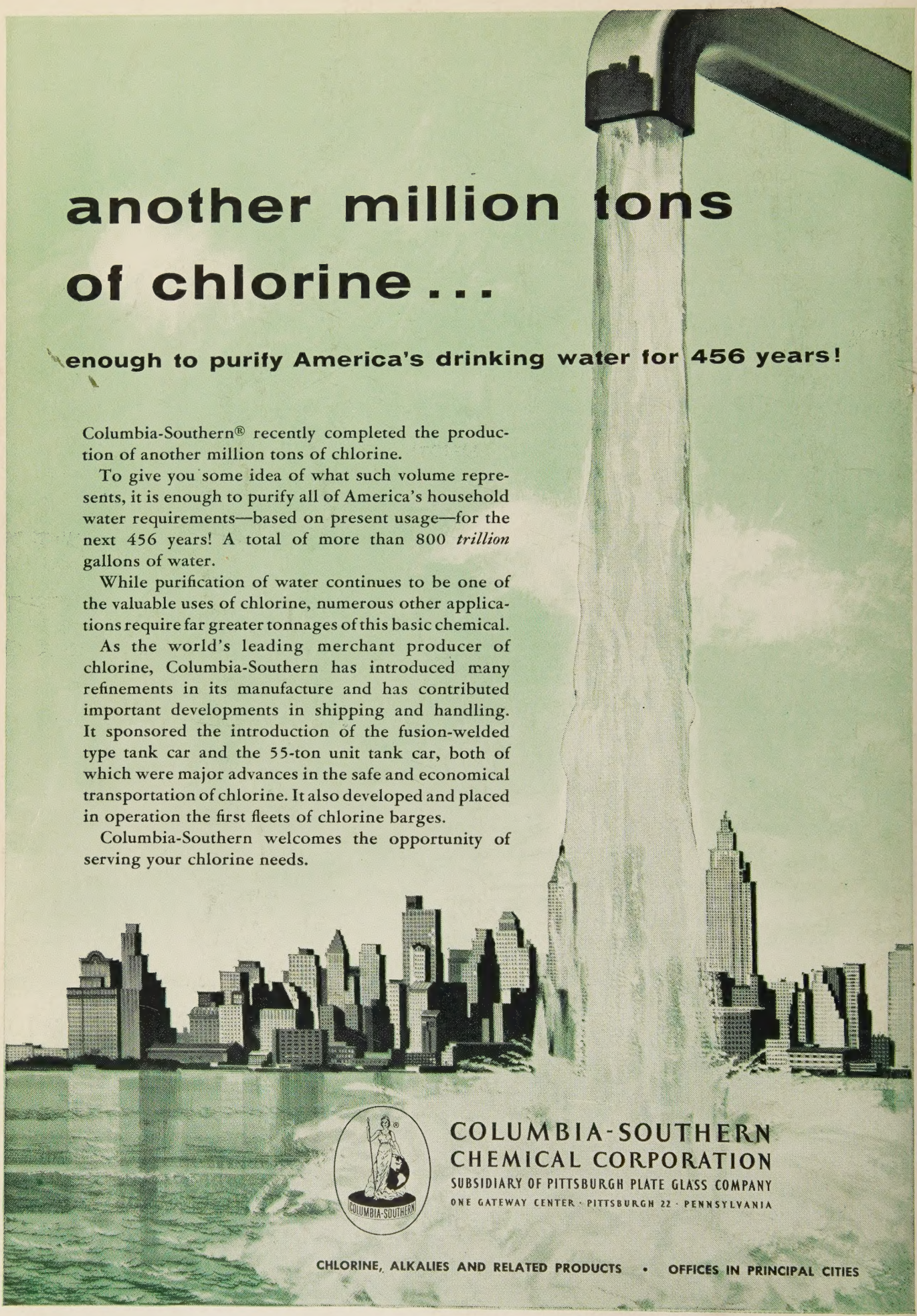
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